ROADS AND STREETS

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Photo Courtesy U. S. Bureau of Public Roads
Where the Pavement Immediately Behind the Mixer Used to Be Full of Men It Is Now Frequently Full of Mechanical Equipment

Time Studies of Highway Contract Operations

Methods of Eliminating Avoidable Delays and Increasing Production in the Construction of Highways

By C. F. ROGERS

Assistant Highway Engineer, Division of Management, U. S. Bureau of Public Roads

THE Division of Management of the United States Bureau of Public Roads is entering its seventh year of study of highway production problems and the methods of eliminating avoidable delays in the construction of highways.

In the prosecution of this work no sacrifice of quality is involved. Quality is not affected by turning waste time into productive time. Increased production is the natural result of steadier operation and more complete utilization of existing equipment. Hand in hand with both of these goes a steady improvement in quality. Regularity and uniformity of mechanical operations contribute to qualitative as well as to quantitative results.

The work of eliminating delays and increasing production is based essentially on time studies which take the Bureau's management engineers into the field on all types of going projects. On these jobs typical operation is recorded by careful time studies of all operations and delays. After classifying the delays according to cause and classifying them as avoidable and unavoidable, the problem becomes one of finding ways and means for the elimination of those which are classed as avoidable. Ways and means are frequently suggested by the cause of the delay. However, these must be carefully studied in order to determine whether or not the cost of the delay will support any scheme necessary for its elimination. Sound economic reasoning must always demonstrate a worth-while saving or improvement in order to warrant a change of operation.

In practically all lines of modern highway work the daily or hourly cost of operation under a set of conditions is practically constant for any given outfit, regardless of whether the production is at capacity rate or at only a fraction thereof. Consequently, spreading a practically fixed overhead, plant, and organization cost over an increased production naturally means a decreased unit cost. To the extent that the individual operator decreases unit costs by this means, he increases his profits and deserves a greater reward for more competent management. Likewise, to the extent that the general contracting profession raises the standard rates of production the general public shares, since in the long run keenness of competition forces unit bid prices to follow unit costs very closely.

Analysis of 1929 Program.—In order to ascertain the possibilities for national saving by eliminating delays and increasing production in highway work, let us analyze a portion of the federal-aid highway program for the fiscal year 1929. In that year the concrete pavement which was completed under federal aid and for which final payment was made totaled 2,832.3 miles and cost $99,447,738, or approximately $35,100 per mile. Including approximately 300 miles of concrete pavements reported completed but for which final payment had not been made, we have a grand total for the year of about 3,135 miles of concrete paving. If it is assumed that 300 paving outfits worked in building this mileage at the average rates of production which have been determined from time studies on about 100 jobs, then the hypothetical average project would be about as follows:

Length of project in miles	10.5
Cubic yards per mile (average section for nine states)	2,155
Cubic yards in project	22,515
Gross rate in cubic yards or batches per hour	19.5
Cubic yards per eight-hour day	156
Total hours required	1,154
Total days required (excluding Sundays and holidays)	144
Days required per mile	13.8
Cost per mile (average cost for six states)	$37,500
Cost per mile for federal-aid project (average of all completed and paid)	$35,112

Time Distribution.—On the basis of the average operating rates and conditions as determined from a summary of all concrete jobs which have been studied, the time distribution responsible for these production rates and costs may be itemized for the hypothetical project about as follows:

	Per Cent	Hours	Per Cent
Total available time	......	1,154	100.0
Major unavoidable delays	......	240	20.8
Residual time	......	914	79.2
Minor unavoidable delays	......	91	7.9
Residual effective time	100.0	823	71.3
Major avoidable delays	30.0	247	21.4
Residual time	70.0	576	49.9
Minor avoidable delays	12.9	106	9.2
Total productive time	57.1	470	40.7

Photo Courtesy U. S. Bureau of Public Roads

Many Pieces of Equipment All of Which Must Be Coordinated for the One Purpose of Producing Square Yards of Finished Pavement

Major delays are stops of 15 minutes duration or more, and minor delays are those of less than 15 minutes duration. Delays are classed as avoidable if in a time distribution of other contracting managers operating under similar circumstances they do not appear, and unavoidable when they appear regularly, and are obviously not preventable by management. Rain, wet grade, frozen ground, moving, and in some instances mechanical failure of equipment are typical of unavoidable delays.

Generally indicative of the avoidable delays and the causes which lead to them are deficient management, lack of or deficient superintendence, lack of authority of the superintendent, "family affairs" in contracting organizations, lack of cost system, failure to plan work, neglect and abuse of equipment, failure to purchase and insure proper delivery of materials both to the job and to the mixer, failure to provide sufficient water for mixing and curing, and especially the general lack of synchronization of the rates of the various portions of the work, such as subgrading, placing joints and steel, and finishing, together with poor plant set-ups.

Cost of Delays.—Second only to the necessity of ascertaining the various delays and their causes is that of determining their cost. Table I has been prepared of the rate of production resulting from the elimination by stages of avoidable delays, reconstructing the time requirements for five assumed degrees of efficiency in the conduct of the hypothetical paving project. Actual or observed average rates of operation are tabulated together with those resulting when one-fourth, one-half, three-fourths, and all of the avoidable delays are eliminated.

An efficiency of 89.2 per cent, or that which results from operation with three-fourths of the avoidable delays eliminated, seems possible of attainment. The Division of Management has recorded and analyzed several jobs which have attained this rate of operation and which have been fully in accord with specification requirements.

By determining the difference in the cost between actual average operation and the possible rate of operation, there is obtained a rough measure of the cost of all delays in highway operations and of the amount which might be made available as a saving or for additional construction. The comparative estimates of unit costs which follow are based on a large modern concrete paving outfit having a charge of $300 per day for labor and $150 per day for equipment, and operating respectively at the general average and the possible observed rates of efficiency (Table II).

Thus, by eliminating the delays which are generally avoidable on a mileage equal to the annual federal-aid concrete paving operations alone, a saving of about $7,000,000 annually might be effected.

From the low rates of operating efficiencies observed in other types of highway work such as grading, rock

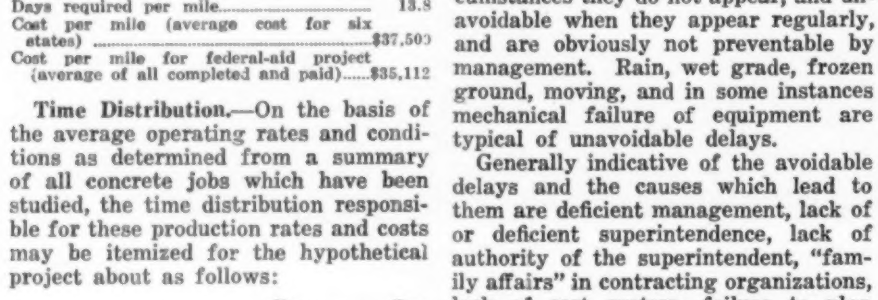


Photo Courtesy U. S. Bureau of Public Roads

Fast Shovel Operation Is Impossible When Loading at or Near the Limiting Height and Reach of the Shovel. Wagons Should Be So Placed as to Permit Fast Operation and High Production

Photo Courtesy U. S. Bureau of Public Roads

In Concrete Paving Work the Mixer Is the Key Equipment and the Main Purpose of All the Other Equipment Is to Keep It Continually at Work

Table I

Items	General Average Operation Hrs.	General Average Operation Pct.	Avoidable Delays Eliminated ¼ Hrs.	¼ Pct.	½ Hrs.	½ Pct.	¾ Hrs.	¾ Pct.	All Hrs.	All Pct.
Total required time	1,154	100.0	973	100.0	840	100.0	739	100.0	660	100.0
Avoidable delay	353	30.6	224	23.0	129	15.3	57	7.7	......	......
Working time	823	71.3	694	71.3	599	71.3	527	71.3	470	71.3
Unavoidable delay	331	28.7	279	28.7	241	28.7	212	28.7	190	28.7
Utilized time	470	40.7	470	48.3	470	56.0	470	63.6	470	71.3
Cubic yards per hours available	19.5		23.1		26.8		30.5		34.1	
Cubic yards per hour worked	27.4		32.4		37.6		42.7		48.0	
Cubic yards per days available	156.0		184.8		214.4		244.0		272.8	
Cubic yards per days worked	219.2		259.2		300.8		341.6		384.0	
Days required	144.3		121.6		105.0		92.4		82.5	
Days per mile required	13.8		11.7		10.1		8.9		7.9	
Real efficiency per cent	57.1		67.7		78.5		89.2		100.0	

TABLE II

	General Average Rate 57.1% efficiency	Possible Rate 89.2% efficiency
Labor cost per cubic yard	$ 1.92	$ 1.23
Equipment cost per cubic yard	.96	.62
Materials cost per cubic yard	7.80	7.80
Other items per cubic yard	6.72	6.72
Total cost per cubic yard	$17.40	$16.37

	General Average Rate 57.1% efficiency	Possible Rate 89.2% efficiency
Cost per mile (average of six states)	$ 37,500	$ 35,280
Cost per job	392,000	368,000
Cost of 3,135 miles	117,600,000	110,400,000

crushing, and bituminous surfacing, it is fair to assume that the losses in all other classes of highway work are, in general, about equal to the above. In fact, indications are that, in proportion to the money expended, they are greatest in grading operations. If this is applied to all highway work in the United States, then an improvement in the operating efficiencies on all types would result in a possible saving of over $50,000,000 annually, since all federal-aid highway work forms roughly one-eighth of all present rural highway work in the United States.

These estimates or approximations are intended to call attention to the savings which are possible under more efficient operation. Here is a problem in management which merits the serious consideration of engineers as well as contractors—a problem which for its effective solution demands the full co-operation of both of these interested parties.

Method of Study.—The first requisite for the elimination of delay lies in obtaining accurate information as to the amount and cause of each type of delay. The Bureau's procedure for accomplishing this may be described as follows:

In tracing job-study procedure a grading, principally of solid-rock excavation with the power shovel will be assumed. The conduct of a typical study will be traced; the methods developed, the forms used, the data derived, and the manner of using these to speed up production will be described.

The project to be studied is selected and assignment of an engineer is made by the Chief of the Division of Management following recommendation by the Section Chief after conference with state highway officials, the Bureau's district officials, and the contractor. The assigned management engineer proceeds to the project and his first work is to acquaint himself with the personnel, the equipment to be used, and the conditions which govern the work. He secures a copy of the plans, prepares a mass diagram if there is none, determines the number of hauling units required, and proceeds through the work making a list of the equipment in use, identifying each machine as to size, capacity, age, and condition. From the contractor or equipment dealer he obtains data on the new cost of each unit. He also lists the typical organization and later secures from the contractor the rates on all labor in order that he may evaluate lost time and delay. Having obtained this information he is ready to start the study.

Twice each day for a period of one hour he makes a stop-watch time study of the operation of the shovel. This is recorded on a form having the following fifteen general headings: state, county, job, number, date, make of machine, traction, size, conditions, number, kind and capacity of hauling units, kind of material encountered, haul distance in hundredths of a mile, condition of haul-

Photo Courtesy U. S. Bureau of Public Roads

The Business End of the Mixer Is Still One Place Where Husky Men Find Plenty of Opportunity to Raise a Sweat

ing road, depth of shovel cut, and kind of work done, whether casting or loading. Using a single-punch stop-watch of standard make he divides the operations of the shovel into load, swing, dump, and return, and records these components of the shovel cycle in seconds and the angle of swing for each in degrees. At the end of the random hour he adds up and obtains average values for the shovel cycle. This average becomes part of a weekly recapitulation. Two such studies made at random—one in the forenoon and one in the afternoon—have been found to agree very closely with the continuous rate of operation. By means of these studies the cause and duration of all minor delays of shovel operation are recorded. At the close of the study hour they are summed up and the percentage of time lost due to each separate cause is determined.

A separate notebook record is also made of the cause and duration of all stops or delays of 15 minutes or more standing time which comprise the time constant. These include the seconds required to load, turn at the shovel, unload, turn at the dump, and all waits and delays. All pertinent data of road and vehicle are recorded. From these data the average typical operation of each unit is derived, together with the necessary data required to compute adequate hauling unit supply.

At the end of the first week and every week thereafter a weekly production report is made of the operation of the power shovel by days and a record of the hauling equipment which is used, together with loads hauled and other pertinent data. On the reverse side of this form all major delays are recorded in hours and are totaled for the week.

A second weekly report which accounts for all labor in man-hours for each key position and for all general labor is made. On this form there is also a record of all supplies used at the shovel, for drilling and blasting, at

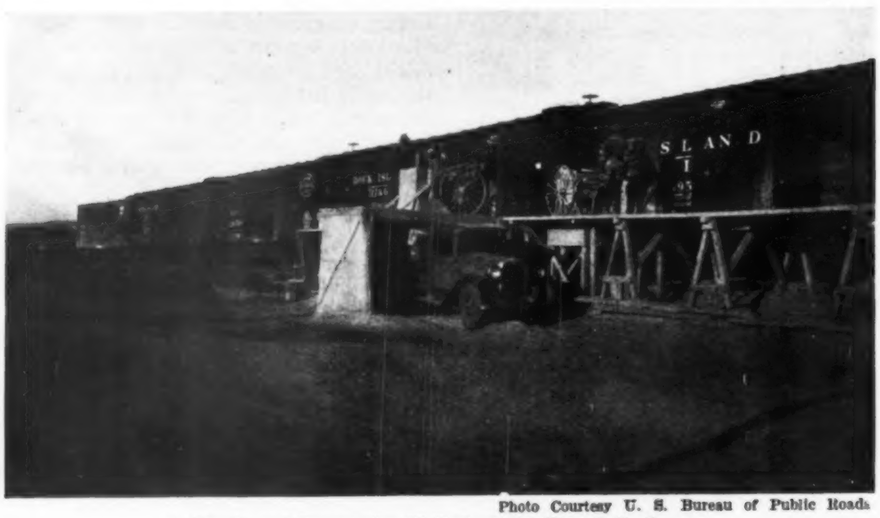


Photo Courtesy U. S. Bureau of Public Roads

A Simple and Inexpensive Method of Handling Bulk Cement

and which are designated as major delays. A diary of pertinent data likely to affect job production is also kept.

The first cut that is opened is either cross-sectioned for total quantity or else this is obtained from the plans. As the study is continued through this cut and each successive one, the engineer determines from the time studies the actual net rate of operation in dipper loads per hour, the total hours of actual operation, the total hours available for shovel operation, the cause and extent of both major and minor delays and also derives the actual yardage per dipper load from the quantities which are moved from the cut. As the time study proceeds he records the dipper loads per truck or wagon and thus derives also the actual pay-yards per load.

In the meantime, alternating with the shovel studies, studies of hauling operation are made and recorded. This study divides the vehicle time into actual hauling time both loaded and empty and the several components of the dump and for hauling. All repair parts and explosives used are recorded together with supporting cost data.

Separate studies of drilling and blasting are made when these operations are found to limit or control production at the shovel. This operation is divided into the time actually drilling, various necessary operations and avoidable delays, in order to obtain the unit rate of equipment such as, for instance, two jackhammer drills and one compressor.

As occasion arises or necessity requires, studies are made of individual workmen or gangs. In these studies the time is divided by seconds into working time and delays, the latter being classified as avoidable or unavoidable. This study is made chiefly to facilitate the weeding out of inefficient labor and to determine the man-power required for group operations when production is at various rates. This information is recorded on a special form.

Formula for Determining Economical Number of Hauling Units.—By the end of the first week, the production studies together with derived cost data are usually sufficiently indicative of actual conditions and possible improvements to warrant an investigation of the job for the purpose of determining the economical number of units of hauling equipment to hold in readiness for use throughout the entire job. This is an important problem, since an inadequate supply of hauling equipment frequently is responsible for the largest loss due to any one cause. The method has been fully developed and explained in an article in "Public Roads," the official organ of the Bureau. Briefly, it makes use of the formula:

$$N = \frac{2L}{St} + \frac{T}{t}$$

where N is the number of hauling units required; L is the haul in feet; S is the average speed of the hauling unit in feet per minute; T is the total time constant in minutes; and t is the time in minutes required to take on load or the longest regular stop of hauling unit. This formula may be applied to any particular set of conditions by making use of the above variables.

Since the length of haul is never constant, the variation in the number of units needed usually means that for any economical number of hauling units the shovel is at times either oversupplied or undersupplied. In case of oversupply there is no increase in production corresponding to the decreased production for undersupply. Thus in individual cuts, if the cost of this decreased production for under supply is calculated to equal the cost of the oversupply of hauling units in other cuts, there will be one number of hauling units which will administer most economically to the needs of the shovel on the whole job.

Average Hauling Cycle.—For what might be called the average hypothetical power shovel highway grading job, which is based on the general average of over 100 jobs studied, the shovel production is 42.8 cu. yd. per hour for the time that the shovel is manned and ready for operation, and six dipper loads of ½ cu. yd. per dipper are required to load the truck or tractor. It may be assumed for this hypothetical job that the trucks carry an average of 3 cu. yd. per load, and for long-haul work it would probably be found that the truck studies would show something like the following time for the average hauling cycle:

Operation	Seconds
Delay at shovel	52
Load at shovel	263
Turn at shovel	56
Haul to dump	282
Delay at dump	48
Turn at dump	39
Unload at dump	44
Haul to shovel	270
Total	1,054

If the round-trip distance is 3,312 ft. and requires 552 seconds, then the average speed is 360 ft. per minute, the

Photo Courtesy U. S. Bureau of Public Roads
Wages Form but a Small Part of the Daily Operating Cost of Many Road Building Operations

time constant T is 502 seconds or 8.37 minutes, and the loading time is 263 seconds or 4.38 minutes. Thus, $2L$ equals 3,312, S equals 360, T equals 8.37, t equals 4.38; and from the formula, N, the number of units required, is four. The data at once indicate both low hauling speed and slow shovel operation.

After a week or even less of these intensive studies, data are available for making definite recommendations for increasing production, thus reducing unit costs. A study of the accumulated records at once indicates several causes which probably contribute toward both of these conditions. They may show a shortage of or the bad condition of the trucks, rough road, poor turning conditions, slow hoisting truck bodies, large rocks at the shovel, too large an angle of boom swing, difficult loading with increased time and smaller dipper load, trucks underloaded, and the drilling and blasting being poorly done in order that this work may keep ahead of the shovel. Some, perhaps all, of these conditions are found to prevail.

Means for Reducing Delays.—On further study of the situation ready means for reducing some of the delays soon become apparent. Here are conditions typical on too many jobs. Studies on the tractor and finishing blade show this unit to be actually doing useful work only 23 per cent of the time. This equipment may be used during idle time to put the hauling road in better condition so that the hauling trucks may be able to maintain a speed of 900 ft. a minute, of which they are easily capable, instead of only 360 ft., which they can make on the unrepaired road. Furthermore, each truck is found to be taking 3¼ minutes for turning and delays at the shovel and the dump because of the rough condition of the cut, due to large boulders or to carelessness in manipulating them at the cut or fill.

This information is given to the contractor and his superintendent in the clearest and most concise form possible, so as to indicate both the magnitude of the losses involved and the steps to be taken toward their reduction. The following is typical of the response on the part of contractors on some of the jobs which we have studied. The tractor and blade are used full time in smoothing the hauling road, the dump and the cut. A first-class mechanic is secured to work on all machinery. He interferes with its use during working hours as little as possible and he is given practically full authority to order parts which may soon require replacement.

By the end of the week, due to improvement of the hauling roads, the trucks probably show hauling speeds of from 600 to 700 ft. per minute, thereby largely overcoming what was formerly a distinct undersupply at the shovel on the longest hauls.

What the Shovel Studies Show.—The studies at the shovel on this somewhat typical job probably show a large angle of swing average perhaps as much as 140 degrees and requiring about 13 seconds for swing and return. The pitman is induced to make every effort to spot the trucks alongside the shovel. Overcoming the apparent indifference of the drivers as to the spotting of trucks without regard to facility in loading is largely a matter of giving some one person authority to direct this operation and of making him responsible. As a result of this minor change in loading practice, the swing angle is reduced to an average of 76 degrees, and requires only nine seconds for swing and return instead of 13 seconds.

The loading time, based on 11.3 seconds per dipper with six dippers to the load, consumes 67.8 seconds, but other delays add 195.2 seconds to each truck load. A part of this is due to the operator, because he feels that if he maintains too fast a rate of operation he will soon be stopped by the need of more blasting. It is, therefore, necessary to speed up the drilling and blasting. At this time, in anticipation of improved production, the shovel operator and mechanic are instructed to completely overhaul the machine during the first enforced major delay and to make certain that insofar as possible all necessary parts are on hand before the shovel is dismantled.

In rock work much time is usually lost due to the inability of the drilling and blasting crew to keep ahead of the shovel and also from poor or insufficient blasting. Thus on this typical job the studies may be expected to show that as much as 28 per cent of the time which should be available for drilling is lost in major delays and that 66 per cent of the working time is consumed in minor delays and necessary operations, so that only about 25 per cent of the total time is actually utilized in drilling holes at a gross rate of about 4½ ft. per hour of available time, or at a net rate of 18 ft. per hour.

To assist in relieving this condition, the superintendent is induced to add an

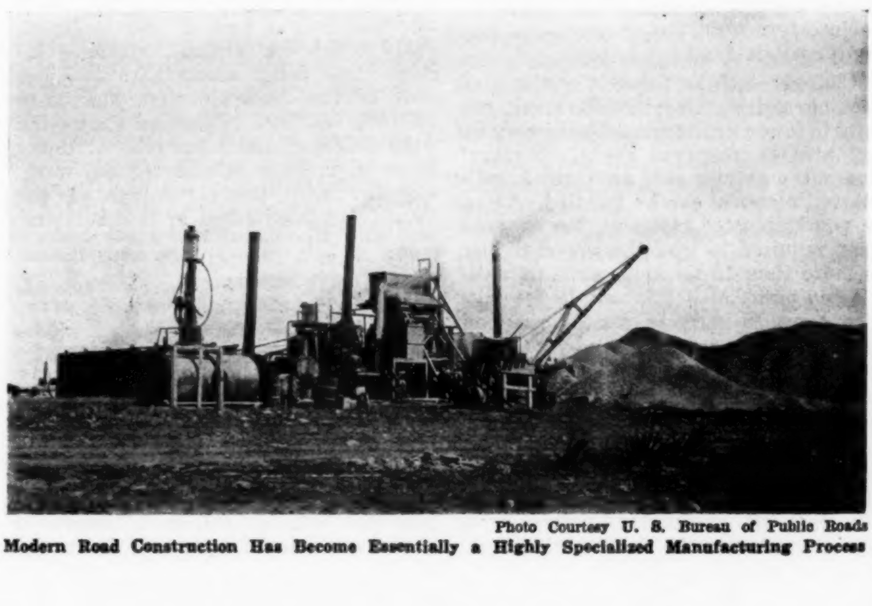


Photo Courtesy U. S. Bureau of Public Roads
Modern Road Construction Has Become Essentially a Highly Specialized Manufacturing Process

additional man to the blasting crew. He is to remove the overburden from hole locations which are spotted by the powder foreman, assist in moving from one set-up to another, and to help generally in reducing the time required for necessary operations incidental to drilling, such as sorting drill steel, carrying worn steel to the blacksmith, returning sharpened drills, and furnishing the proper lengths to the drillers as needed. The mechanic spends some time after working hours tuning up the compressor.

Improving Blasting Operations.—With poor or indifferent blasting the material breaks large and it is difficult for the shovel operator to handle the load. In stratified ledges of unequal hardness or toughness it is sometimes found that all the material may be loosened from the floor of the cut, while some of the overlying ledges are only lifted but are not shattered. The disadvantage of this procedure having been indicated, the powder foreman is directed to drill easer holes between the regular full-depth holes. These holes stop in the rock ledges. With battery firing and delay caps these easers are set off first and shatter the ledge rock just ahead of the force of the main charge. This operation produces a material which is much easier for the shovel to handle.

Another cause of poor breakage is the shooting of each new series of holes against the restraint of the loosened rock of previous blasts. This disadvantage being shown, the powder foreman is directed to withhold firing, whenever possible, until most of the loosened material of the previous shot has been removed by the shovel. By this means, each new shot presents a face free in two directions. This permits better breakage and requires less powder. Also, the practice of the drill crew of going into the cut and holding up the shovel while large boulders or rocks are plugged or capped and broken, is stopped by shifting this work to the noon stop and the evening. The practice of permitting dependent operations to interfere with the operation of key equipment is faulty.

Changes such as these in methods of drilling and blasting usually result not only in lower drilling and blasting costs, but also in improved shovel operation due to the greater ease with which well-blasted material can be handled. Thus, in poorly blasted material, the average time required to load the shovel dipper is more than 15 seconds, while in well-blasted material it is about 10 seconds. The average yardage per dipper load is also increased frequently by as much as 20 per cent, so that where, for example, six dippers were required to load a truck it could now be done with five.

Effect of Changes on Production.—As an illustration of the effect which changes such as these would have on the rate of production, reference is again made to the hypothetical job. The new hauling cycle is about as follows:

Operation	Seconds
Delay at shovel	32
Load at shovel	114
Turn at shovel	38
Haul to dump	152
Delay at dump	24
Turn at dump	21
Unload at dump	29
Haul to shovel	163
Truck cycle	573

It will be recalled that this cycle was originally 1,054 seconds. This quickening of operations necessitates an increase in truck supply as indicated below. Hauling 3,312 ft. (the round-trip distance) in 315 seconds gives an average speed of 630 ft. per minute with a time constant of 258 seconds or 4.3 minutes and a loading time of 1.9 minutes. Thus, $2L$ equals 3,312; S equals 630; T equals 4.3; t equals 1.9; and from the formula previously given, N, the number of units required, is five. On the same basis of 3 cu. yd. per load, this would mean that the shovel operates at a rate of 95 cu. yd. per hour, as compared with about 43 cu. yd. per hour at the beginning. To secure this increase in production one truck and driver has been added, a mechanic and a couple of additional laborers have been employed, and a little more powder is being used. The cost of these items per cubic yard of material, however, is small compared with the increase in the net rate of production from 43 to 95 cu. yd. per hour. The real effect of utilizing waste time is, therefore, to decrease the unit production costs at very nearly the same rate as the production is increased.

How Time Losses Affect Shovel Operations.—To illustrate further how these time losses affect the various operations in power shovel highway grading work, reference may again be made to the typical average job of approximately 50,000 cu. yd. and compare the results obtained under average management and under very good management.

The difference in the cost between average management and the best management is the cost of the avoidable delay which the average manager incurs. The delay amounts to 46.7 per cent of the available time and costs $23,900. A final tabulation shows the percentage of the total cost of delay incurred in each subitem of the work, together with the percentage of the total delay contributed by that subitem:

	Per cent of total cost of delay	Per cent of total avoidable delay
Loosening	20.1	43.2
Loading	25.1	18.4
Hauling	35.5	29.7
Constructing fill and finishing	16.8	2.5
Supervision and general	2.5	6.2

This table includes, in addition to major and minor avoidable delays, the losses incurred by average management due to slow operation. These are 10.2 per cent loss by reason of increased shovel cycle, and 8.4 per cent due to decreased dipper load. It is interesting to note that the ablest management saved 166 hours by decreasing the shovel cycle 7.1 seconds and 100 hours by increasing the dipper load 0.1 cu. yd.

With 43.2 per cent of the delay contributed by drilling and blasting operations, this loss cost nearly $4,800 on the job, or 9.7 ct. per cubic yard. On the whole, this is one of the most inefficient of the operations observed in rock work. Whenever the cost of labor and equipment for this work, in cuts of about 6 ft. and more, exceeds the cost of blasting materials, it is a rough indication that either the crew is grossly inefficient or that the false economy of trying to save powder is being practiced.

By failure to provide and maintain an ample supply of hauling equipment at the shovel, the average contractor loses some $8,500 on the job, or 17.1 ct. per yard of material handled. And with a contribution of 29.7 per cent to the total job delay, too much emphasis cannot be laid on this factor. Sufficient hauling equipment must be provided, and it must also be given a fair opportunity to develop the speed and capacity for which it was designed.

Conclusion.—While in a broad sense all losses and delays are traceable to management of highway operations, this is not always true of operation costs. It is entirely probable that some of our accepted traditions of specification requirements may generate costs in our work far beyond the intrinsic value which may result. Quality irrespective of price is uneconomic. Expenditures available for improved highways lag behind the need for these improvements. Engineers and contractors must realize that the greatest development for both professions is through cooperative efforts to extend these funds over as great a mileage as possible.

Acknowledgment.—The foregoing is a paper presented at the 1930 Highway Conference at the University of Colorado.

Progress of Cuban Central Highway.—According to reports given out by the Public Works Department, over eighty per cent of the Central Highway section uniting the cities of Havana and Pinar del Rio has already been completed by the American contracting firm in charge of this section of the work. With the exception of a bridge in the town of Artemisas and a distance of 110 kilometers (68 miles), the road is completely finished between Arroyo Arenas and Paso Real de Sandiego. It is estimated that the entire road through Pinar del Rio province will be completed about May 20, at which date the Cuban contractors in charge of the construction of the highway through the provinces of Matanzas and Santa Clara plan to turn over to the government the section of the road uniting Havana and Santa Clara.

Penetration Macadam, Design and Construction

Some Notes on the Practice in the State of Rhode Island

By C. L. WOOLLEY

Construction Engineer, Rhode Island State Board of Public Roads

BITUMINOUS, or so-called penetration macadam, was officially recognized as pavements in 1912 by the Association for Standardizing Paving Specifications. Their definition was "The bituminous macadam pavement consists of crushed stone and bituminous material incorporated together by penetration methods." Devised at a time when a rapidly increasing number of motor vehicles was ripping water-bound macadams out before the contractors could get the towns and cities to accept the work, these "penetration macadams" promised wonderful service for a few years.

Used as a cure for all highway ills, built on any kind of a subgrade and constructed with little or no finesse, "penetrations" lost "caste" after a few years of trial when they failed to give adequate service. Failures under the methods of construction then in vogue could be predicted in from two to three years.

The Rhode Island Design.—Realizing that penetration macadams gave excellent service during the summer and fall months and that the critical period was in the spring during which the combination of thaws and loads soon reduced poorly constructed roads to mixtures of stone and mud, a rational design was attempted which would give an all-weather pavement at reasonable cost.

To indicate how well that design has stood the test of years in Rhode Island I would call your attention not only to the roads built since that period but to the fact that that design has only been changed in detail and not in basic principle since its inception.

Briefly that design consisted of:

1. A stabilized sub-soil or sub-grade plus adequate drainage facilities.
2. A layer of crushed stone compacted and bound together with sand or crusher dust.
3. A layer of crushed stone penetrated and sealed with asphalt.

I do not believe a discussion of subsoils and their treatment is properly a part of this paper. Enough to say that no flexible type will stand up on poor sub-soil in an improperly drained location. Our use of granular material (run of bank gravel) to stabilize sub-soils has been successful. It is, however, based on the "Rule of Experience" and is probably uneconomical, as we also go on the principle that it is better to be safe than sorry.

The real scope of this paper is to develop and discuss a rational design for penetration macadam which can be simply, speedily and economically constructed by the contractor and which will give 10 to 15 years of good riding service to the public.

Naturally designs can be made which will eliminate, in theory, the weaknesses of this flexible type, but the field methods necessary to put these designs into practice prove either so uneconomical or so retarding that they defeat their own purpose and are either evaded or cancelled in the field. Such designs would include the thickened edge, the grouting or penetrating of the outside 2 ft. of the base and various other plans of the same nature. If these operations could be done simply, speedily and accurately, thus incurring no delay to the contractor or state nor adding considerable amount to the cost, they would be justified. They do not, however, meet these requirements and for these reasons have not been adopted.

This leads us to a discussion of the design and construction of base courses, and top courses and to the composition and quantity of the bituminous material.

The Base Course.—The ordinary base course of a bituminous macadam is a layer of crushed stone from 1 in. to 5 in. in size and anywhere from 3½ in. to 7 in. thick, rolled and filled with either sand or crushed dust, all tightly compact and presenting an open mosaic surface on which to place the top stone. These main requirements, thickness, compactness, and open surface, are essential.

By "thickness" we lower the intensity of the wheel load pressure on the subgrade; by "compactness" we develop high lateral restraint and obtain better distribution of the wheel loads over the sub-grade and by "open surface" we not only aid the bond between top and bottom courses but we prevent loose sand from entering the voids of the top stone which would prevent complete penetration. The quality, size, and shape of the material used in constructing the base course must meet these basic requirements and no more. In Rhode Island our base course thickness is 5½ in. after rolling. We use either crushed stone or crushed and screened gravel between 1 in. and 4 in. in size. We use either crusher dust from 0 to 1 in. in size or sand passing a ½-in. screen for filler. Our stone quality requirements are: toughness 6, French coefficient of wear 6, and the gravel must show not more than 15 per cent of loss by the Rea abrasion test. These requirements may appear too lenient but an impressive list of pavements showing no signs of distortion or failure would seem to justify their use. The use of large size stone and crushed and rounded particles of gravel has not been difficult to handle in the field and we have had no difficulty in obtaining "compactness" by the ordinary methods of rolling and sanding. We believe the key to success in obtaining a compact base course is in the rolling of the stone or gravel before any filler is applied. This prevents the filling and choking of the voids and the resultant loose uncompacted pockets in the base. It is also essential to apply the filler in small doses and "sanding and rolling" should be considered one construction operation.

We believe further that the essential requirement of "compactness" can be better met by a crusher graded stone or gravel from 1 in. to 4 in. in size than by an arbitrary commercial mixture of 1½ in. and 2½ in. crushed stone. The voids of our larger sizes are successively filled by graduations of smaller sizes until we finally bind the mass with sand or dust. The so-called, commercial stone on the other hand has 30 to 40 per cent voids approximately of the same size and it is with difficulty that "compactness" is gained when binding with sand passing a ½ or a ¼-in. screen.

If thorough "compactness" has been obtained the sweeping of either type of base is simple but essential. Horse-drawn brooms may in dry weather get off a large percentage of excess filler, but hand brooms will then be needed to get the edges. In wet weather it may be necessary to use hand brooms over the whole surface of the base. If a good bond between the top and bottom courses is to be obtained this operation of brooming must be done thoroughly.

The Top Course.—The old rule for the pentration course is that the thickness of the course, the top size of the stone and the quantity of the asphalt shall be the same. This rule would indicate the necessity of meeting the following basic requirements.

1st. That the course should be as thin as practicable to reduce overturning and shoving.

2nd. That the stone should be as large as practicable to provide an even distribution of large voids.

3rd. That the quantity of the bituminous matrix should neither underfill the voids and cause ravelling nor overfill the voids and cause shoving.

What we often forget when applying this rule is that the thickness of the layer must in practice be slightly more than the top size of stone. Thus a 2½-in. course of 2½-in. stone becomes when rolled 3 in. thick, due to the physical difficulty of applying crushed stone but

one stone deep. We also forget that this rule applies to stone in the finished pavement. In other words a 2½-in. stone at the crusher unless of extreme hardness may become through injudicious rolling a 2-in. stone plus a few ½-in. chips. Thus we may easily have a 3-in. layer of 2-in. stone uneven as to voids, and choked with chips before penetration. Should we, on the other hand underroll in order to reduce this breaking of the top stone, we then sacrifice the benefit of the natural mechanical bond, which is of great benefit in the elimination of "shoving." A further construction difficulty of this 3-in. layer of 2-in. stone is the obtenance of complete penetration. Where chips have formed and the stone broken down under rolling in such a way that small voids are present the bituminous material instead of penetrating becomes a seal coat covering uncoated loose stone. The large quantity used to penetrate a 2½-in. to 3-in. layer is then spread over a small area of no depth and a slippery fat spot results which may in extreme cases cause a hole when the uncoated top stone underneath is subjected to loads.

Therefore, the rational design of the top course to meet the construction requirements would seem to call for a large, extremely well graded, and extremely hard stone, laid in as thin a course as is practical. We, in Rhode Island, call for a 2½-in. layer of trap rock. This stone must be retained on a 1½-in. screen and pass a 2½-in. screen. It must be rolled before penetration to develop the mechanical bond between the stone. It must be clean and the voids must be open.

The removal of small spots of ashes, the re-screening of small areas of dirty top-stone, the condemning of whole cars of commercial grade of trap sent through as top stone, the removal by hand of leaves, sticks and other debris may seem picayune but it is only by the enforcement of these requirements for hard, well graded, clean top stone with clean open voids that excellent riding and lasting bituminous macadam is built. Mr. G. H. Henderson's paper on the "Causes of Success and Failure of Bituminous Macadam," presented before the annual Asphalt Paving Conference in November of 1926, covers these points in detail.

The Bituminous Materials.—The basic requirements for the bituminous materials which penetrate and bind the top course into a finished road are few but essential. As stated before the quantity of material should neither underfill the voids causing "ravelling" nor overfill the voids causing "shoving." The material should be ductile in cold weather but should not melt and flow during hot weather. It should be a material which will retain these characteristics over a period of years.

In our climate where the range of air temperatures is from 0° F. to 100° F. and where the road surface temperatures range from 10° F. to 150° F. an asphalt having a ductility of at least 30 and a penetration limit of 85-100 seems to meet all of the above conditions. By applying this material at the rate of 1¾ gal. on the penetration course and using ¾ gal. on the seal coat we seem to have met the "quantity" requirement as no ravelling nor shoving has appeared in our bituminous macadams built in the last ten years. It is unfortunate that the bad results of using too much asphalt in the penetration course or of using asphalt of too high a penetration, do not appear for two or three years. Almost every penetration road which develops corrugations and waves under traffic has had so much bituminous material shot into the top course stone that this stone is floating in the material. The practical maximum limit on the quantity of asphaltic binder, when a hard, durable stone is used, seems to be 2 gal., measured cold. When a stone which has a tendency to chip under rolling is used, this quantity of asphaltic binder must be reduced.

The minimum practical limit is approximately 1.5 gal. measured cold. By using less than this the chances of having ravelled spots develop under traffic is increased.

Estimating Quantity in Distributor.—An interesting and important field problem in the application of asphalt binders is the estimating of the quantity in the distributor. Asphalt increases in volume when heated and does not flow freely until heated to about 225° F. Thus a distributor loaded at a refinery takes on a load at from 225 to 350 deg.

On the job the load must be heated to 350° F. or 375° F. to get good penetration. The quantity required in the road, however, has been figured at 60° F. or what is known as "cold." To add to the confusion some companies weigh the asphalt, thus eliminating the variation in volume, while other companies merely rate the volume of their tank trucks at 800, 950 or 1,000 gal. of material whether hot or cold.

That this expansion amounts to something both in money and material is evident when we realize that asphalt expands 10 per cent in being heated from 60° F. to 350° F. We have worked out the following rules for handling this problem:

1. We buy the asphalt by weight and are billed so many tons converted into "cold" gallons.
2. We pay the contractor who "heats, hauls, and applies" the material the same gallonage that we pay the producer.
3. On the job we convert the weight slip weight into cold gallons and figure our yardage of penetration by dividing by 1¾.
4. When no weight slip is received on the job we take the gallonage rating of the truck and figure our yardage or penetration by dividing by two.

In this way we compensate for the volume charge.

Application of Key-stone.—Oftentimes the difference between a good penetration and a poor one shows during this operation of penetrating and applying of this choke stone. The scattering of this choke stone in such a way that it does not get onto the unpenetrated top stone; the brooming of this stone so that it does not bunch; the using of tar paper or troughs to prevent double laps and fat spots at the start of each distributor load; the leaving of an uncovered strip on half width penetration to prevent a double ridge of choke stone down the center; the cross lapping of penetration and seal coats to eliminate an unsightly center joint; all of these are some of the essential construction details that must be rigidly enforced in order to obtain a good job.

The quality of this choke or keystone should be the same as that required for top stone. The size of it, however, varies with the type of final surface desired by the engineer.

Should he desire an open grained surface showing relatively large gaps between the individual pieces of top stone he should use small key-stone, say ½-in. stone. On the other hand should he want close grained, tight surface he should use a larger key-stone, say ¾-in. stone. This seeming paradox is explained by realizing that the larger sized key-stone fits individually into the various voids whereas the smaller stone is in small pockets and not being glued together with binder is wheeled out by traffic leaving open voids.

The Seal Coat.—The application of the seal coat has fewer troubles than any other operation. Of course the penetration course must be rolled and rolled and then rolled some more. The excess choke stone must be swept off. Debris, such as leaves, twigs, papers, etc., must be cleaned off. From ½ to ¾ gal. per square yard of bituminous binder is applied and covered immediately with a fairly heavy though even layer of ½-in. cover stone. The real job after the application of the seal coat is rolling. Even after the road is thrown open to traffic, rolling should be continued. The binder we find takes from two to ten days to lose its plasticity and during that period every effort should be made to gain "compactness."

I have made an effort through this paper to give a complete synopsis of the methods for constructing bituminous macadam. That has been done frequently and excellently at every technical meeting of highway engineers during the past four years. In fact it is surprising how much has been said about and how little has been done with this excellent type of pavement.

Acknowledgment.—The foregoing is a paper presented at the 1930 convention of the Association of State Highway Officials of the North Atlantic States.

The Widenning and Planning of Highways

Some of the Problems Confronting the Traffic Engineer and Suggested Methods of Solution

By D. R. LAMSON

Assistant Engineer, American Road Builders Association

Highways Outside of Metropolitan Areas

A SURVEY of right-of-way width requirements was made and information was received from twenty-six states. Five of them require a minimum width of 100 ft., namely: Minnesota, Michigan, Mississippi, New Mexico and Wyoming. Five states require a minimum of 80 ft., namely: Alabama, Arkansas, Louisiana, Montana and North Dakota.

Georgia requires a minimum width of 75 ft. and Kansas 70 ft. Colorado, Indiana, North Carolina, Ohio and Tennessee require a minimum width of 60 ft. A 66 ft. minimum is standard in Utah and Wisconsin. A 50 ft. minimum requirement is in effect in Delaware, Idaho, Rhode Island, and Virginia.

West Virginia has a minimum width requirement of 40 ft. and Pennsylvania has requirements ranging between 33 ft. and 120 ft. New York has no requirements but attempts to secure the necessary width, these depending principally on the proximity to the metropolitan areas.

There is, therefore, but little uniformity in state requirements regarding right-of-way widths, but as proof that the trend is toward wider highways, it is found that seventeen out of the twenty-six states have increased their width in recent years by distances varying from 14 to 34 ft.

The maximum limits on state right-of-way width range as high as 150 ft. in several states.

Roadway Widths.—The generally accepted traffic widths of highways as indicated in the survey, are 18 and 20 ft. New York reports a minimum of 18 ft. and a maximum of 40 ft. Pennsylvania reports 20 ft. up. Georgia, Indiana, Minnesota, Ohio, and Wisconsin report a 20 ft. standard width.

The states reporting, indicate conformity with the recommendations of the American Association of State Highway Officials, the requirement being a 10 ft. width for each traffic lane.

Traffic Density.—The necessity does not exist at the present time for the construction of systems of wide highways throughout the country. Except in comparatively small areas, such volumes of traffic do not now exist and will not during the next fifteen or twenty years at least. In a state as a whole there is not necessity, therefore, of planning an ultimate right-of-way in excess of 100 ft. or a roadway surface width in excess of 40 ft. whether a single or dual strip pavement is involved, and on the great majority of the mileage, for a long period of years, even these widths will not be required.

This statement is based on the existing traffic and predicted future traffic on the state and county highways of Wisconsin, the northeastern section of Illinois, Ohio, Pennsylvania, Maryland, Virginia, Connecticut, Vermont, New Hampshire, and Maine. The highways in these areas form a cross section of the highway and traffic conditions in all states.

Four years ago in Ohio there were approximately 11,000 miles in the State Highway System of which only 131 miles were carrying more than 2,500 vehicles per day, including passenger cars, motor trucks, and motor buses. The same relative conditions are found in other areas.

The proportionate mileage carrying a volume of traffic requiring extraordinary pavement widths and design is limited to comparatively small areas, around the larger cities. And if the traffic trends based upon the last twelve years are any indication of future growth it can be safely said that on the bulk of the state and county highway mileage, during the next 10 or 15 years, construction can be largely confined to the provision of two-lane surfaces. A two-lane surface, 20 ft. wide, will carry 8,000 vehicles a day at a speed of 30 miles an hour. These figures take into consideration the normal amount of motor truck and motor bus traffic and are based upon actual research studies dealing with traffic volume, traffic speed, and pavement width.

Recommending Standards.—Pavement widths are thought of in terms of traffic lanes with general agreement on the 10-ft. lane as standard. Odd numbers of lanes are falling into disfavor, except where built as a temporary stage in widening to an even number. Separation of the lanes by boulevard grass-plot strips is not considered good design unless existing street railways make them necessary. This is especially true where traffic flow is predominantly in a single direction at certain hours, as it prevents an increase of the number of lanes used to take care of the directional overload.

The following widths of right-of-way are considered to be reasonable standards:

1. Local roads, limited to two lanes for moving vehicles plus parking—66 to 86 ft.
2. Primary and secondary trunk lines in well-settled communities, limited to four lanes for moving vehicles plus parking—100 ft.
3. Primary highways limited to six lanes for moving vehicles plus parking—120 ft.
4. Superhighways with provision for high-speed motor traffic separate from local traffic, with ten lanes for moving vehicles and four parking strips—200 ft.
5. Special snow-belt trunk highways for two-lane traffic, but with provision for permanent snow fence and protective planting within the right-of-way—150 ft. to 300 ft.

Metropolitan Areas

The Regional Concept.—A logical conception of a region is that of an area including and surrounding a city, extending to the average of the limit of service for all enterprises which

Existing and Required Rights-of-Way

State	What Is Right-of-Way Width Now Existing? Ft.	What Is Present Surface Width Requirement? Ft.	Y Has Right-of-Way Width Been Increased?	How Much? Ft.
Alabama	80	18-20	Yes	30
Arkansas	80 up	22-26-32	No	
Colorado	60-100	18	Yes	to meet requirements
Delaware	50-150	9-54	Yes	to meet requirements
Georgia	75-100	20	Yes	40
Idaho	50-150	no requirements	Yes	
Indiana	60-100	20 up	Yes	to meet requirements
Kansas	70 up	18		
Louisiana	80	18-20	Yes	20
Minnesota	100	20	Yes	34
Mississippi	100	18	No	
Montana	80 minimum	no requirements	Yes	14
New Mexico	100	18	Yes	20
New York	no standard	18-40		
North Carolina	60	18-20	Yes	
North Dakota	80	24	Yes	14
Ohio	60-100	20	No	
Pennsylvania	33-120	18 minimum	No	
Rhode Island	50 up	18 minimum	No	
Tennessee	60-100	18	Yes	
Utah	66-100	18	Yes	to meet requirements
Vermont	50 minimum	18	No	
Virginia	50-80	18	Yes	20
West Virginia	40 up	18-20	No	
Wisconsin	66-120	20	Yes	to meet requirements
Wyoming	100-150	24	Yes	20

have their origin and control in the principal cities and their suburbs.

The important factor in the regional concept is the disregard of political boundaries and the substitution of an area having common economical and social interests.

Regional planning commissions are operating in the following areas:

Boston, Mass
Bridgeport (Fairfield County), Conn.
Brunswick (Glynn County)*, Ga.
Buffalo (Niagara Frontier), N. Y.
Carmel (Putnam County), N. Y.
Chicago, Ill.
Cincinnati (Hamilton County)*, O.
Cleveland, O.
Dallas, Tex.
Detroit, Mich.
Englewood (Bergen County), N. J.
Fort Wayne, Ind.
Houston, Tex.
Kansas City, Mo.
Los Angeles (Los Angeles County)*, Calif.
Milwaukee (Milwaukee County)*, Wis.
Minneapolis-St. Paul, Minn.
New York, N. Y.
Norfolk, Va.
Oakland, Calif.
Oklahoma City, Okla.
Patterson (Passaic County), N. J.
Peoria, Ill.
Philadelphia, Penn.
Pittsburgh (Alleghany County)*, Penn.
Ponca City, Okla.
Rochester (Monroe County)*, N. Y.
St. Louis, Mo.
San Francisco, Calif.
Santa Barbara (Santa Barbara County)*, Calif.
Seattle (King County)*, Wash.
Syracuse (Onondaga County), N. Y.
Toledo (Lucas County)*, O.
Tulsa, Okla.
Washington (Md. National Capitol), D. C.
White Plains (Westchester County), N. Y.

*Note: Official county organizations operating under permission state legislation.

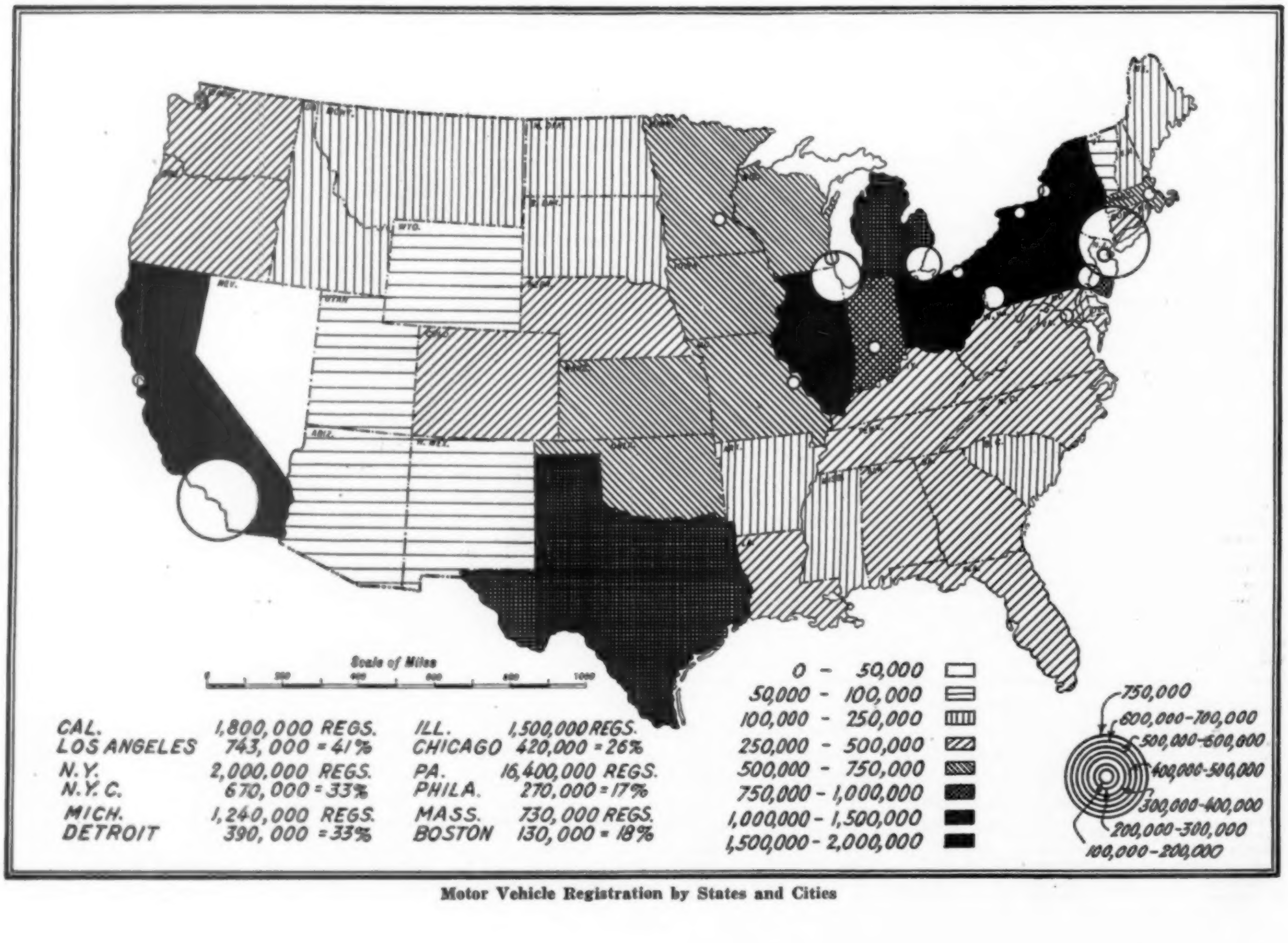
Size of Regions

New York Region—
Population—10,000,000.
Area—5,528 sq. mi.
Includes parts of New York and Connecticut, 22 counties and 436 cities and villages within a 50 mile radius of New York City.
Chicago Region—
Population—5,000,000:
Area—7,800 sq. mi.
Includes parts of Illinois, Indiana, and Wisconsin, 15 counties and 250 cities and villages within a 50 mile radius of Chicago.
Philadelphia Region—
Population—3,400,000.
Area—4,000 sq. mi.
Includes parts of New Jersey and Delaware within a 30 mile radius.
Boston Region—
Population Central City—779,620.
Regional area—400 sq. mi.
Buffalo (Niagara Frontier)—
Population Central City—555,800.
Regional area—1,550 sq. mi.
Milwaukee (Milwaukee County)—
Population of Central City—544,200.
Regional Area—240 sq. mi.
Rochester (Monroe County)—
Population Central City—322,200.
Regional area—663 sq. mi.
Toledo (Lucas County)—
Population Central City—313,200.
Regional area—325 sq. mi.
Santa Barbara (Santa Barbara County)—
Population Central City—25,000.
Regional area—2,500 sq. mi.

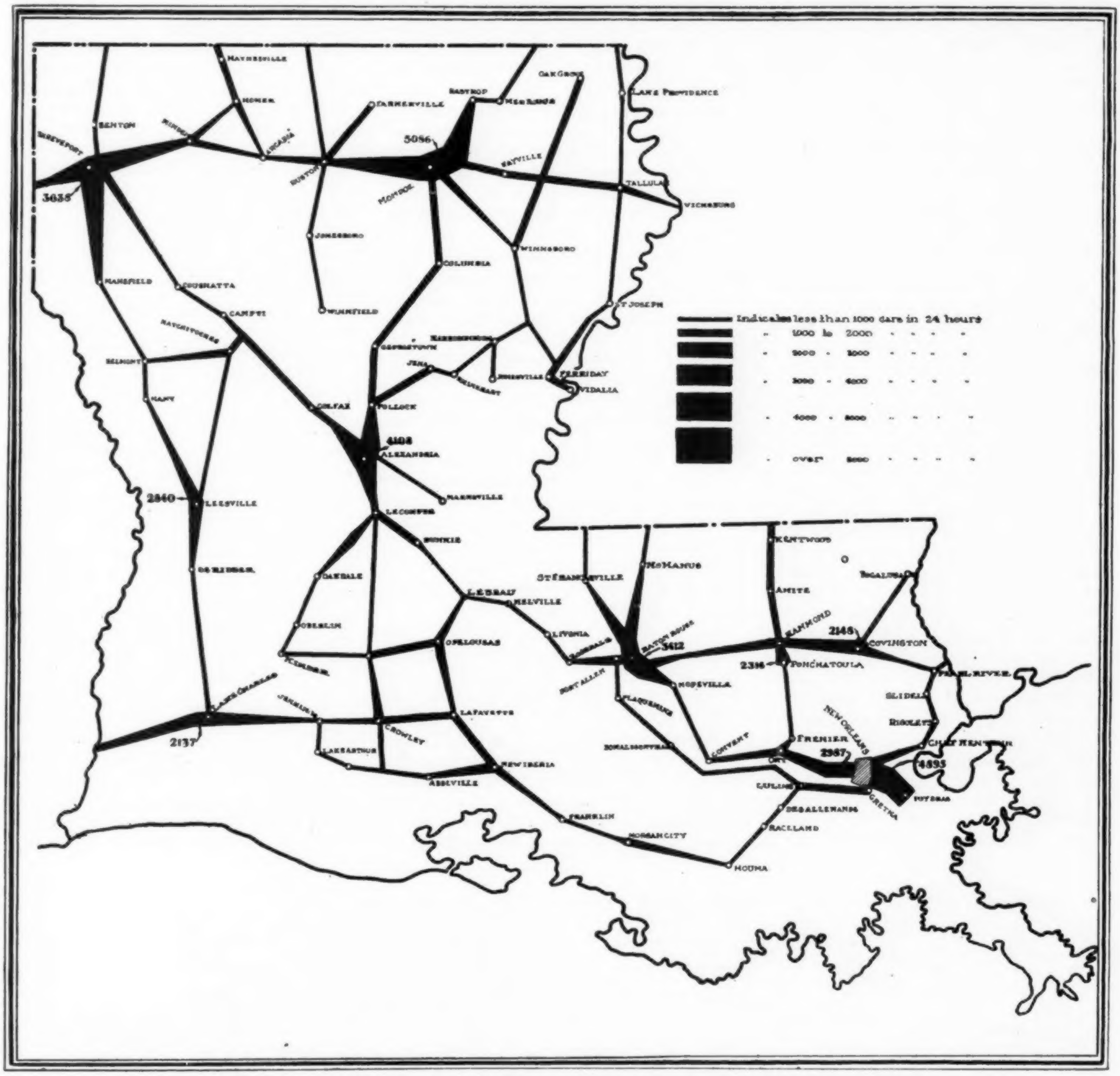
The principal causes for traffic congestion are as follows: (a) high registration local vehicles) (b) outside registration using highways in the area (c) lack of parking restrictions (d) narrow and poorly planned highway systems (e) lack of adequate entrances and exits (f) in nearly every instance the larger cities are geographically hemmed in by waterways thus making the problem more difficult.

The centers of population mark the centers of concentrated traffic passenger cars and motor trucks, and particularly of large-capacity trucks. The maximum extent of local use out of these centers is thirty miles. This distance scales down approximately ten miles around the smaller cities. It is in these areas that we find traffic conditions which set the maximum standards of right-of-way, surface width and of pavement design. In the same areas occur the most expensive construction projects, the highest costs of additional right-of-way and the greatest obstacles to the successful completion of highway improvement program. This is especially true of the central sections of our cities where insufficient right-of-way was originally set aside for highway purposes.

Thirty miles from the heart of the central city of a regional area is the maximum distance of local influence. The New York Area could even be included within the limits of this maximum. Obviously there is a certain amount of "through" long-distance traffic in any area and of traffic which travels beyond this 30-mile zone but these amounts are very small when compared with the local traffic operating within the confines of the area. In the Cleveland Area, only 1½ per cent of the passenger car traffic on the main roads crosses the regional areas be-



Motor Vehicle Registration by States and Cities



Map of Louisiana Showing Density of Traffic According to November, 1928, Traffic Census Report

tween outside points. On the other hand, over 95 per cent of the daily passenger car traffic entering or leaving the City of Cleveland does not travel beyond the limits of the regional area, 30 miles from the center of Cleveland.

This is the type of facts upon which the selection of the area to be included in a region should be based. The boundary of the area should be the average limits of the service for the enterprises which have their origin and control in the central city. In regional Highway Planning these limits are the extent of local traffic service.

Type of Organization and Legal Basis.—The types of organizations which are carrying on regional planning work may be classified into four general groups. (1) Unofficial promotional associations (2) Official county planning commissions (3) Official regional planning commissions and (4) Unofficial regional planning associations.

To date there are only a few states which have permissive legislation for the establishment of regional organizations such as Ohio, Pennsylvania, New York, California, Wisconsin, and Georgia.

The final solution of the legal problem will be the enactment of legislation to authorize the establishment of regional planning organizations with power to enforce their recommendations.

Financing of Regional Organizations.—There are four general methods of financing: (1) contributions by members in the case of unofficial associations (2) a combination of membership and governmental contributions (3) private endowments and (4) regular governmental appropriations or tax levies.

The following figures give an idea of expenditures necessary to carry on surveys and make plans.

New York	$1,000,000	(7 years)	**Surveys and master plans**
Philadelphia	500,000	(3 years)	**Surveys and master plans**
Chicago	75,000	(annually)	**Surveys and master plans**
Los Angeles	70,000	(annually)	**Surveys and master plans**
Cleveland	45,000	(annually)	**Surveys and master plans**
Milwaukee	40,000	(annually)	**Surveys and master plans**

It is estimated that the lowest cost of a satisfactory highway plan would approximate $20,000 to cover a 10-mile radius around a small city. $80,000 would be sufficient for any area in the United States with the exception of the three largest cities. Highway plans should cover expansion needs of a region for a period of at least fifteen years.

Necessity for More Routes in Regional Areas.—The main part of regional work has to do with the recommendations concerning reconstruction or widening of existing roadways on one hand and the construction of entirely new routes on the other. There is evidently a lack of sufficient connections between the center of population and industry and the tributary area. This means the establishment and construction of new arterial highways. Evidence obtained indicates that traffic does not want to be concentrated on a few main routes. It does not all start at or near the end of one route and when an attempt is made to pour it all out at the other end of the route congestion is created. More distributing routes are required rather than excessive widening of existing routes.

Parallel Two-Lane Highways.—On the other hand parallel two-lane highways offer no solution to the traffic problem because of the low capacity of the two-lane highway. It has been well demonstrated that the traffic capacity of the four-lane highway is between three and four times that of the two lane, due to the increased efficiency in separation of slow and fast vehicles. Parallel highways should not be considered until the present highway has been developed to at least a 40-ft. width. Considerable right-of-way cost is justified in preserving the investment in the old highway.

Recommended Widths of Pavement.—Where moving traffic is the principal factor, roadway widths of 20, 40 and 60 ft. are recommended. These widths should be increased by 16 ft. on entering cities in order to secure parking lanes.

Reasons for Regional Failures.—The failure to carry out recommended regional plans by many cities has resulted in the loss of the funds invested. The ratio of actual execution to the number of plans recommended is very low. The reasons are as follows:

a. Lack of adequate engineering facts upon which to base recommendations.

b. A large majority of plans are idealistic and not practical, with no method of changing from present conditions to the ultimate ideal development.

c. Lack of financing.

d. Lack of the establishment of the priority of various interests.

e. There has been a general failure to provide for an active organization sponsoring the plan and directing public opinion toward the complete execution of the plan.

Regional Planning Accomplishments.—Regional planning organizations are evidently the solution of traffic problems in congested areas. The accomplishments by regional bodies such as those operating at Cleveland, New York, Chicago, Detroit and White Plains are outstanding.

The following tabulation is an example of the 10-year plan of improvement actually being carried out in Cleveland.

The new routes to be established include 68 miles of 40 ft. pavements and 60 miles of 20 ft. pavements.

New construction on present location includes 5 miles of 40 ft. pavement and 70 miles of 20 ft. pavement.

Reconstruction and widening includes 80 miles of 40 ft. pavement and 310 miles of 20 ft. paving. Total mileage equals 594.

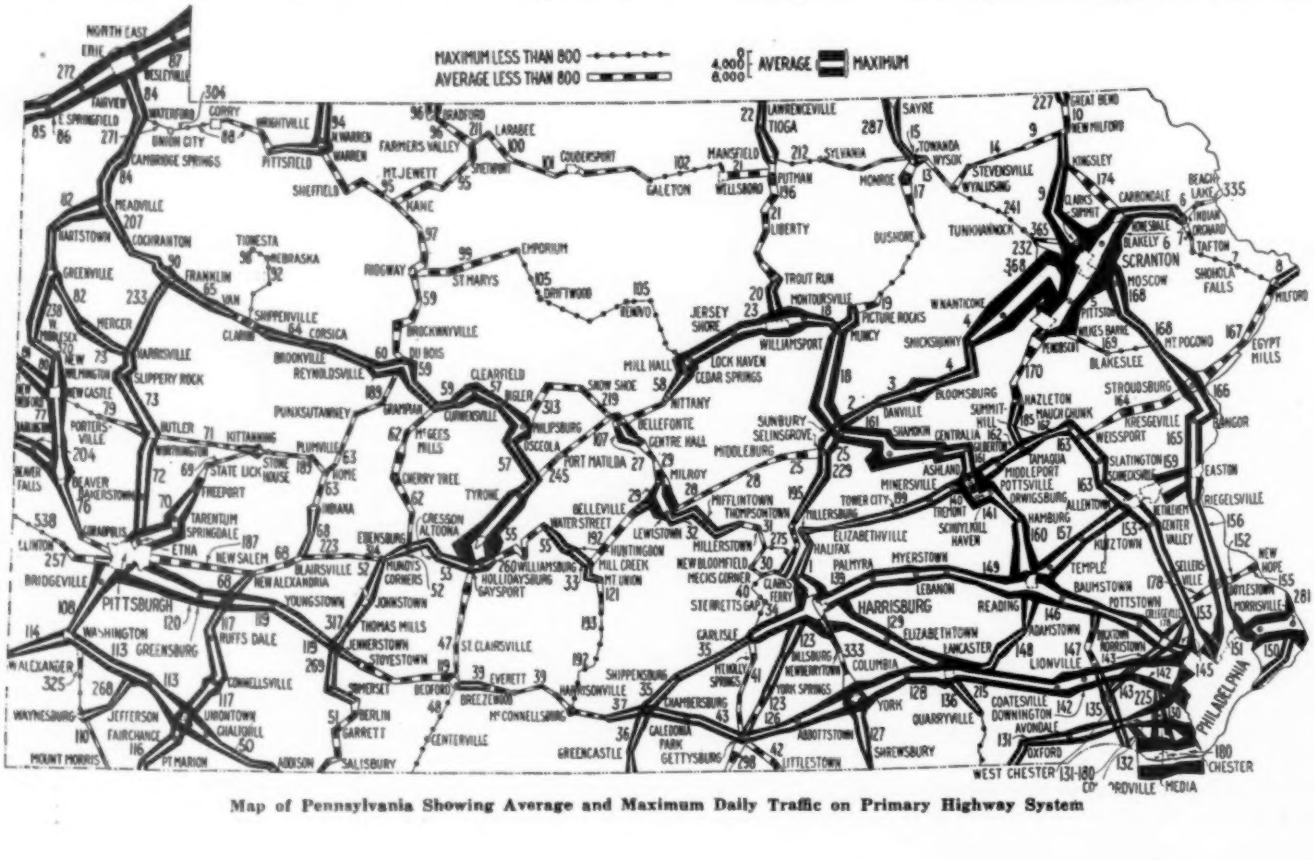
The program includes four new bridges and seventeen replacement, all on old routes. The program also calls for the elimination of fifty-five grade crossings.

The total cost of the ten year program is estimated at $63,000,000.

Arterial thoroughfares have been the item of major interest and constitute the backbone of the master plans which have been prepared in most of the areas.

Detroit is outstanding in its efforts to put its master plan into effect, although its plan provides for 204 ft. superhighways at three mile intervals and 120 ft. highways at one mile intervals throughout the regional area. The state legislature has acquired by purchase or condemnation, two-thirds of the right-of-way required for the fulfillment of the master plan. The city of Detroit is assisting financially in the development of the master plan.

The Milwaukee, Boston, Los Angeles and Westchester County regions are following a master plan in their road



Map of Pennsylvania Showing Average and Maximum Daily Traffic on Primary Highway System

Vehicle Time Lost at Selected Grade Crossings in Cleveland Regional Area

Road	Railroad	Location	Highway Traffic 7 a. m. to 7 p. m.	Rail Traffic 7 a. m. to 7 p. m. Trains	Time Blocked 7 a. m. to 7 p. m. Hours	Vehicles Stopped	Per Cent of Time Blocked	Per Cent of Vehicles Stopped	Total Vehicle Time Lost (Vehicle Hours)
E. 72d St.	N. Y. Central	W. End Gordon Park	7,752	75	1.69	1,078	14.1	14	23.6
Lorain Ave.	N. Y. Central	Near W. 143d St.	5,955	84	2.48	1,867	20.6	31.4	46
Broadway	Wheeling and Lake Erie	At Union Ave.	14,220	33	.62	600	5.2	4.2	12.1
E. 93d St.	Erie	Near Meech Ave.*	4,372	42	1.20	709	10.0	16.2	30.6
E. 93d St.	Wheeling and Lake Erie	Near Meech Ave.*	4,372	35	1.18	650	9.8	14.9	23.7
U. S. Rt. 20	Nickel Plate	West of Pinesville	4,799	18	.89	319	7.4	6.6	16.4
			41,470	287		5,223			

*Crossings 300 ft. apart; blocking of one crossing impedes traffic at other.

construction while the Chicago Association has brought about cooperative work in the construction of several major highways which were delayed by jurisdictional difficulties.

The work done in Westchester County, New York, is outstanding. It has developed 16,000 acres of park land, nine miles of beach, and shore line and 140 miles of parkway right-of-way, 33 miles of which is paved 40 ft. wide.

Park systems are under way in the Cleveland, Milwaukee, Detroit, and Niagara Frontier regions.

The Philadelphia area is accomplishing much in the preservation of stream valleys.

The National Capital region is rapidly developing an adequate regional park system.

Platting control is well in hand in the Chicago, Milwaukee, Los Angeles, Toledo, and the National Capital regions.

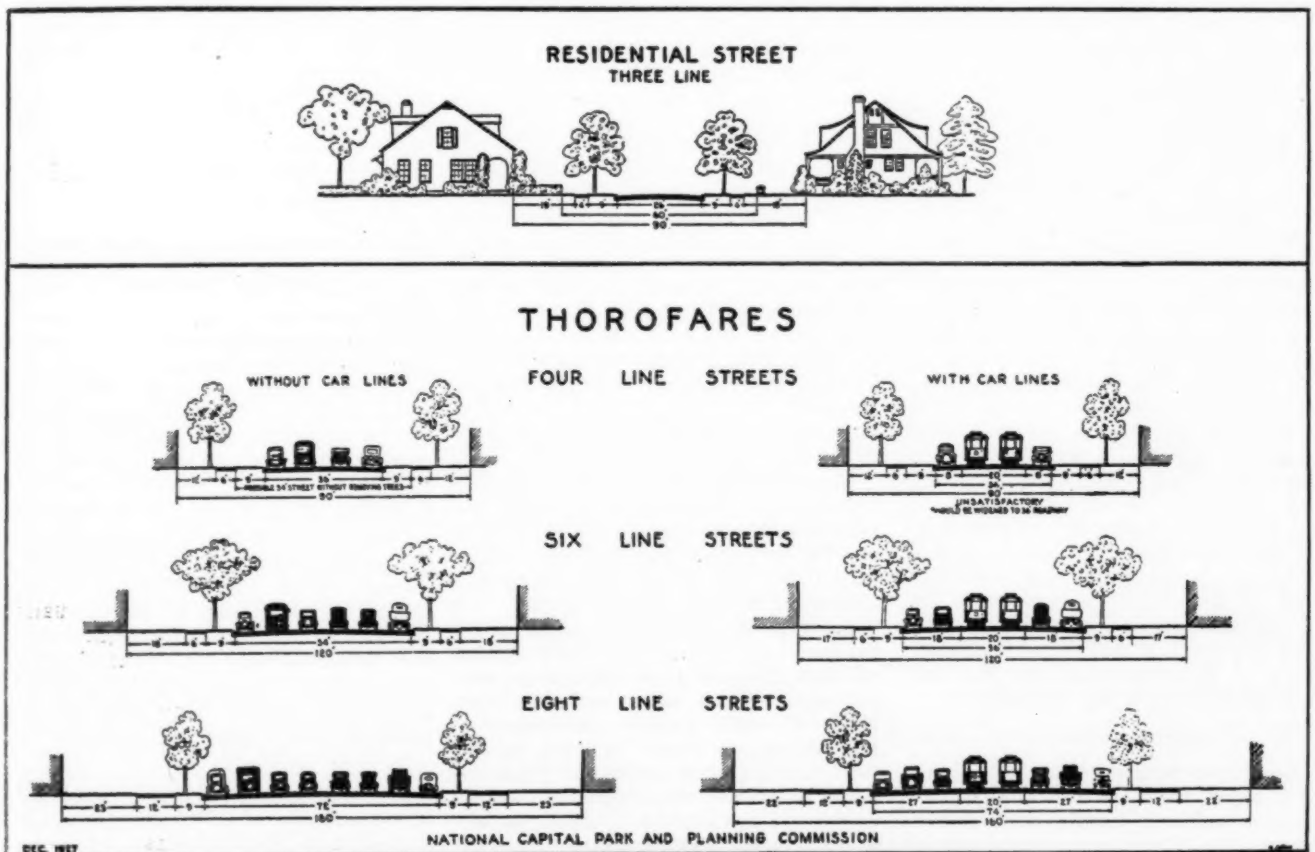
Cost of Traffic Congestion.—The cost of traffic congestion is estimated at $81,000 a day in Boston, $600,000 a day in Chicago prior to the inauguration of the regional improvement program and $1,000,000 a day in New York.

The loss of time by reason of traffic congestion in large cities is making transportation by horse drawn trucks more economical than by motor driven vehicles. The motor driven truck no longer has a time saving advantage and therefore does not warrant the large capitalization.

Lack of highway facilities has retarded the purchase of automobiles in several large cities, notably, New York, Chicago, Philadelphia, and Boston. Per capita comparison of registration figures were made with such cities as Detroit and Los Angeles which have an abundance of wide exits and high speed arteries. Using the per capita ratio of 3.5 persons to the automobile which exists in Detroit the four former cities would have a total increase in registration of 1,950,000 automobiles. Wayne County, in which Detroit is located, has 400 miles of good 40 ft. pavement.

Grade Crossings.—The following statistics are included herewith for the purpose of giving an idea of the part played by grade crossings in the congestion of traffic.

The record of grade crossings in existence shows that the number is actually increasing in spite of a constant and growing program of elimination. This condition results from the ill advised creation of new crossings, in many cases quite unnecessary. In 1924, there were 232,710; in 1925, 233,701; in 1926, 235,159, and in 1925 235,446.



Typical Street Cross Sections of National Capital Park and Planning Commission

At present the authority to create new grade crossings lies usually with the administrative body authorized to open or to accept newly opened roads. Such authority should be confined to the state highway departments or to some state public utility commission, and new crossings should only be permitted when the need is demonstrated as sufficiently great and where no other route or solution is possible at the time.

Time Losses Caused by Traffic Congestion at Grade Crossings.—The extent of time lost and congestion caused by grade crossings is indicated by the results of the following traffic survey.

From these analyses it is quite clear that cases can exist where there is a distinct and considerable loss of time to the public flowing directly from the grade crossing. On such crossings the time which is lost may be stated in terms of efficiency of the highway as follows:

Case 1, above cited, indicates a high way 86 per cent efficient, the reduction from full efficiency being due to the existence of the grade crossing. Case 2, above cited, is 79 per cent efficient. Case 3, is 95 per cent efficient, and case 4, 90 per cent efficient and so on.

This condition does not, however, represent the total loss of efficiency of the highway due to the grade crossings. In some states, notably North Carolina, Louisiana, Mississippi, Florida and Nebraska there are crossing stop laws, requiring all approaching automobiles to come to a full stop before entering the intersection. In some cases the law requires a reduction of speed to a rate at which the automobile will be completely controllable within a few feet. The speed fixed in Nebraska on secondary crossings is 12 miles per hour. These laws apply to all traffic on all roads of the state and represent, if observed, another source of lost time, required in an effort to attain safety at grade crossings. If such methods are adopted in all states the total losses in highway service will be enormous.

The ratio of night to day traffic using the period from 7 p. m. to 7 a. m. indicates that the vehicle hours loss may be increased by 50 per cent to arrive at the 24-hour loss. In the cases cited these full day losses would be respectively 35.4 vehicle hours, 69, 18.1, 45.9, 35.5, and 24.6. If we assume that the use of an automobile is as valuable as its operating costs we are very conservative in assigning one dollar an hour as the cost of the lost time. The above losses, so charged and capitalized at 6 per cent would justify expenditures of $215,350, $419,750, $110,108, $279,225, $215,958, and $149,650.

Recommendations

1. Recommending that state highway departments have traffic departments capable at making surveys necessary for planning of highways for relief of congestion.

2. Recommending that state legislative action be urged for the purpose of authorizing and controlling the organization of regional planning commissions in congested areas.

3. Recommending that equitable methods of financing be studied and recommended.

4. Recommending that in locating highways state highway departments build trunk lines around cities rather than through them.

5. Recommending the adoption of a minimum right-of-way width of 100 ft. for primary and secondary trunk lines.

6. Recommending the adoption of a minimum right-of-way of 66 ft. and a two-lane roadway for local roads.

7. Recommending that the authority for the location of grade crossings should be vested in the State Highway Commission or some state public utility commission.

8. Recommending the immediate financing and construction of specific projects in regional area as recommended by the commissions in charge of the planning in these areas.

9. Recommending that state and county highways having an average daily present traffic in excess of 4,000 vehicles shall be designed with more than two traffic lanes of pavement. Highways having an average daily present traffic between 1,200 and 4,000 vehicles not more than 10 per cent of which is truck traffic shall be designed with two traffic lanes, generally paved. Roads having an average daily present traffic of less than 1,200 vehicles not more than 10 per cent of which is truck traffic shall have two traffic lanes with some type of weather surfacing.

Federal Aid Apportionments

Secretary of Agriculture Arthur M. Hyde, on April 7, apportioned among the 48 states and Hawaii the sum of $48,750,000 of the additional $50,000,000 authorized by Congress as Federal aid for highway construction in the fiscal year beginning July 1, 1930. This supplemnetary appropriation for Federal aid highways was authorized by the bill signed by President Hoover on April 4, which also authorized the appropriation of $125,000,000 for each of the fiscal years 1932 and 1933.

The additoinal $50,000,000 brings the authorized appropriation for 1931 to $125,000,000. Congress provided $75,000,000 by a previous act, and Secretary Hyde apportioned this among the states and Hawaii on Dec. 2, 1929.

All apportionments of Federal funds for highways in the Federal-aid system are based on the area, population and post road mileage of the states, and the share of each state is available for expenditure on roads included in the Federal-aid system under the joint supervision of the state highway departments and the Bureau of Public Roads of the U. S. Department of Agriculture. Apportionment of the 1932 authorization will be made on or before Jan. 1, 1931, and of the 1933 authorization on or before Jan. 1, 1932.

A tabulation of the apportionment to the states as certified by the Secretary of Agriculture, of both the original $75,000,000 authorization and the additional $50,000,000 for the fiscal year 1931 follows:

Apportionment of Federal Aid to the States for Fiscal Year 1931

	Apportionment of Original authorization of $75,000,000	Apportionment of Additional $50,000,000 authorization
Alabama	$1,557,372	$1,038,248
Arizona	1,062,190	708,127
Arkansas	1,293,086	862,057
California	2,501,170	1,667,477
Colorado	1,390,524	927,016
Connecticut	477,893	318,596
Delaware	365,625	243,750
Florida	921,558	614,372
Georgia	1,985,632	1,323,755
Idaho	932,594	621,729
Illinois	3,100,781	2,067,187
Indiana	1,909,505	1,273,003
Iowa	2,005,944	1,337,296
Kansas	2,048,585	1,365,723
Kentucky	1,414,610	943,073
Louisiana	1,040,195	693,463
Maine	675,106	450,071
Maryland	631,911	421,274
Massachusetts	1,090,022	726,682
Michigan	2,200,177	1,466,785
Minnesota	2,102,986	1,401,991
Mississippi	1,323,897	882,598
Missouri	2,382,383	1,588,255
Montana	1,552,865	1,035,243
Nebraska	1,586,526	1,057,684
Nevada	960,845	640,563
New Hampshire	365,625	243,750
New Jersey	936,234	624,156
New Mexico	1,190,296	793,531
New York	3,605,965	2,403,976
North Carolina	1,722,673	1,148,449
North Dakota	1,203,060	802,040
Ohio	2,753,528	1,835,685
Oklahoma	1,751,015	1,167,343
Oregon	1,197,667	798,445
Pennsylvania	3,314,707	2,209,805
Rhode Island	365,625	243,750
South Carolina	1,065,105	710,070
South Dakota	1,232,962	821,975
Tennessee	1,608,802	1,072,535
Texas	4,545,830	3,030,554
Utah	850,752	567,168
Vermont	365,625	243,750
Virginia	1,429,253	952,835
Washington	1,156,219	770,812
West Virginia	792,826	528,550
Wisconsin	1,849,169	1,232,780
Wyoming	942,455	628,303
Hawaii	365,625	243,750

An Automatic Police Whistle Traffic Control

A police whistle, automatically timed to sound a shrill blast just before traffic signal lights change color, has been installed in Scotia, across the river from Schenectady, N. Y. The whistle is intended to check motorists who disregard lights and to speed up traffic by awakening dreamy drivers to the fact that the green light has flashed for them.

The device was invented by C. R. Duers of Glens Falls, N. Y. It is operated by electricity, either manually or automatically, just as the lights may be. Power released by a General Electric magnetic coil moves a piston within a cylinder, the resulting blast of air sounding a regulation police whistle.

Readily adaptable to any existing traffic lights, installation of the whistle is not difficult. All working parts are housed in an aluminum case, fully protected from the weather.

Surface-Mix Type of Oiled Roads

Methods and Cost of Constructing 46 Miles of Oil-Surfaced Roads in Colorado

THE surface-mix type of oiled roads is being quite extensively constructed in California, New Mexico and Colorado. At the 1930 Highway Conference at the University of Colorado a number of papers treating on this type of construction were presented. The two articles following were submitted as discussion at the Conference.

Methods and Costs on 9¼ Mile Job

By J. J. VANDEMOER

District Engineer, Colorado State Highway Department, Grand Junction, Colo.

A 9¼-mile federal-aid project which was completed during the past construction season is the first oil-surfacing project to be constructed in the writer's division. The original gravel surfacing over which most of this oil treatment has been applied had been constructed about seven years ago. Crushed river gravel having a maximum size of 1½ in. and placed 4 in. thick and 18 ft. wide with a top course of ¾-in. crushed gravel 2 in. thick was used in its construction. This surfacing was thoroughly wetted, rolled and compacted using a natural silt binder which contained little clay or adobe.

Preparatory Work.—This road had carried heavy traffic for about seven years with little renewal of the surfacing and with no subgrade failures until last spring. Last winter there was a great deal of snow and rain in this region and as the drainage system was not in good repair, when the spring breakup occurred, there were a few subgrade failures. These failures occurred as "frost boils," and were corrected by raising the grade at these places and by reestablishing the drainage system during the construction of the oil-surfacing project. Pit-run gravel with a maximum size of 2 in. was used in the grade raises. This was placed in thin layers and thoroughly compacted under traffic.

On account of heavy traffic the original gravel surfacing was practically worn away so it was necessary to rebuild this to a minimum thickness of 4 in. before the surfacing gravel was placed. The new surfacing was thoroughly compacted by traffic before the oil-surfacing material was placed.

It is thought that the subgrade is stable and that it will carry traffic satisfactorily as long as the drainage is kept open, and in order to protect the subgrade as much as possible the drainage on this project was brought back to the original plans. The surfacing gravel was spread 20 ft. wide and approximately 3 in. thick. This compacted to about 2½ in.

The Surfacing Material.—Frequent mechanical analyses of the process material were made and the mix was held as uniform as possible. The material passing the 200-mesh screen, varied from 9 per cent to 15 per cent. Average analyses were as follows:

	Per Cent
Passing ¾-in. screen	99.7
Passing ¼-in. screen	62.4
Passing No. 10 screen	57.7
Passing No. 200 screen	12.2

On one section an average of 9 per cent of the surfacing material passed the 200-mesh screen and only 1.52 gal. of oil per square yard was used on this section. This seems to have been ample for it is one of the best sections on the project.

The same relative conditions seemed to hold on the entire project and indicated that in order to keep the cost of oil as low as possible it was advisable to use a material of which 9 or 10 per cent would pass the 200-mesh screen.

The specifications on this project permitted from 5 to 15 per cent of the surfacing material to pass the 200-mesh screen but it is believed that from 5 to 10 per cent would have been more economical and would have resulted in the construction of just as good a road as was built.

From 1.52 to 2.21 gal. of oil per square yard was used on this project. The average was 1.88 gal. per square yard exclusive of the seal coat.

The most serious difficulty occurred on a 2-mile section which was placed under ideal weather conditions. This stretch of road was oxidizing satisfactorily under heavy traffic when the fall rains set in. Rain fell for about two weeks. The traffic was heavy and wherever water stood on the road the oil seemed to leach out of the surfacing. Grades are very flat on this project and for this reason water does not drain off quickly; the shoulders had not been sufficiently pulled down and the finished surface had not been brought to as smooth a condition as possible, so there were depressions in which water collected. As a result of this combination of circumstances raveling started. It was decided to tear this section up and to add another quart of oil per square yard. Satisfactory results were obtained.

Processed Material Should Be Dry.—Experience indicates that too much care cannot be taken to insure that the processed material is thoroughly dry. Frequent moisture tests should be made. More than two or three per cent of moisture is likely to cause cracking followed by corrugations.

Owing to the difficulties which had been encountered and on account of the presence of excessive moisture during construction and after the oil surfacing was completed, it was decided to seal coat the entire project. An average of twelve-hundredths of a gallon of oil per square yard was spread over the entire project. Fine sand and silt were used to absorb the excess oil and for a mulch on the surface of the roadway. The seal coat was about ⅛ in. thick. Traffic was turned on each section as fast as it was seal coated.

The seal coat cost 2.7 ct. per square yard. It is believed that the money which was spent on the seal coat was wisely used. To date practically no raveling has occurred on this project. This road has carried as high as 2,000 cars per day during the fruit season, and seems to be handling traffic satisfactorily.

Costs.—The unit prices and other items of interest on this project are as follows:

Item	Unit Prices	
per cu. yd.	Borrow excavation	$0.35
per ton	Pit-run gravel	0.98
per ton	¾-in. gravel	1.10
per gallon	Asphaltic road oil	0.085
per sq. yd.	Processing	0.055
per sq. yd.	Scarifying and harrowing	0.04
per sq. yd.	Cost of seal coat (F.A.)	0.027
gal. per sq. yd.	Oil used exclusive of seal coat	1.88
gal. per sq. yd.	Oil used for seal coat	0.12
per cent	Total oil used on project	6.05
per sq. yd.	Total cost oil surfacing complete in place	0.517

The total cost was $5,175.52 per mile. This includes a section 1,800 ft. long and 30 ft. wide through the town of Palisades and the necessary deferred maintenance cost.

Adverse weather conditions increased the costs, as did tearing up and relaying the above-mentioned two miles of oil surfacing.

The total contract cost per mile as submitted in the final estimate was $6,169.56. This includes grade raises, new surfacing material, asphaltic road oil, processing (scarifying and harrowing the section that had to be torn up), seal coating, drainage and incidentals. These costs are high but considering conditions are not believed to be excessive.

Equipment.—The contractor used the following equipment:

1 gravel crushing and screening plant.
1 set of scales to weigh gravel.
5 new 2-ton G. M. C. trucks.
1 set heavy road disc harrows.
2 Adams leaning-wheel graders with 8-ft. blades.
2 Caterpillar tractors, number thirty.
1 two-ton Caterpillar tractor maintainer.
1 light rubber tired maintainer.
1 distributor, capacity 1,150 gal., owned and developed by the Gilmore Oil Co., which company furnished the oil.
1 10-ton steam roller, used for heating the oil in the railroad cars.

Conclusions.—As a result of experience on this project, the following conclusions may be drawn:

(1) The subgrade must support traffic satisfactorily before oiling.

(2) Water in any form is the most dangerous enemy of an oiled road.

(3) Drainage must be as thorough as possible or failures will occur at points of insufficient drainage. In other words, ground water and surface water must be kept as low as possible.

(4) At least 4 in. of old, well-compacted surfacing makes a stable subgrade. If loose material is put between the base and the oiled surfacing, there is a tendency toward rutting, shoving, and breaking.

(5) Too much oil is almost as bad as insufficient oil.

(6) No clay should be present in the process material.

(7) Sufficient inert fines to fill the voids will produce the most economic road with a minimum amount of oil. Fuel oil will not bind clean, coarse material, and if the material will not pack without oil, it will not pack satisfactorily with oil.

(8) Heavy clay binder in the process material is not desirable.

(9) A road that breaks up in the spring or becomes muddy in wet weather should not be oiled without making the necessary drainage corrections.

(10) The processed material should not be laid down if it contains an appreciable amount of water.

(11) A satisfactory oiled road may be built with one-inch maximum surfacing material.

(12) Careful maintenance is necessary.

Acknowledgment.—The general contractor was Hinman Brothers with Merrit Hinman in direct charge for the contractor. A. H. Batten, resident engineer, was in charge for the highway department.

Worth D. Ross, of the Bureau of Public Roads, rendered valuable assistance through the entire construction period and M. D. Glenn, engineer for the Gilmore Oil Company, also rendered valuable assistance.

Methods and Costs on 37 Miles of Work

By C. WALTERS

Resident Engineer, Colorado State Highway Department, Fort Collins, Colo.

One of the lessons which has been learned is that the formulas which have been developed in California and New Mexico to determine the required amount of oil do not apply in Northern Colorado. Experience shows that we need even more oil than called for by the New Mexico formula. While the writer thinks that these formulas are valuable as a guide to determine the proper amount of oil in estimating a project and also to give something to shoot at in the field he believes better results can be obtained by observation than by trying to stick too closely to formulas.

With this method the greatest variable is the amount of material which is to be treated. The formulas which have been developed for determining the amount of oil to be used for a given grading of material can not be applied without some accurate method of measuring the material which is to be treated. This can be done by taking a number of cross-sections of the roll of material at intervals, and averaging the results.

Estimating Amount of Oil Required.—In practice there seems to be two methods for the field man to follow. One is to measure the material, compute the amount of oil required, distribute the oil and mix until a uniform color is obtained. If the mixture is too light, spread it out and distribute more oil repeating this process until the desired color is obtained.

The other method is to compute the amount of oil required for the theoretical amount of material which is to be treated, distribute the oil and mix being careful not to pick up more than the required amount of material. When the mixture is of uniform color, more aggregate or oil may be bladed in if the proper color and mixture have not been obtained.

The second method was generally used on our work during the past season. After the aggregate had been worked with one brand of oil for a short time it was not difficult to determine the ratio of oil to aggregate and it was seldom necessary to introduce fresh aggregate after the first mixing and in still fewer instances was additional oil required. The method, in general, was to make the aggregate come to the theoretical amount of oil instead of making the oil come to the theoretical amount of aggregate. We worked on the theory that inasmuch as the aggregate was the harder to measure accurately it would be better practice to allow for variations in this way, keeping always in mind that a certain minimum amount of material is always necessary in order to obtain the required depth of finished roadway.

Experience with the stain test indicates that it is of value as a means of comparison with other tests on the same project. In general, it gives reasonably uniform results, but it can not be relied upon absolutely and should not be followed blindly after sufficient experience has been had to know what color and mix is actually needed for best results.

Another difficulty with the stain test is the impossibility of comparing tests made with different brands of oil. The greatest variation occurs between the light-colored California oil and the dark-colored Wyoming oil.

Classification of Costs.—Costs were classified under the following heads and subheads:

Material:
- Road oil.
- Demurrage.
- Freight on oil.

Preliminary work:
- Moving and assembling.
- Constructing turnouts.
- Repairing hauling road.
- Maintaining ahead of oil.
- Smoothing subgrade.
- Scarifying.
- Spreading gravel.
- Eliminating oversize.

Oiling:
- Heating oil.
- Hauling oil.
- Distributing oil.

Processing:
- Discing oil.
- Picking up, mixing and laying down.
- Compacting.
- Maintaining oil.

Protecting traffic:
- Constructing detours.
- Constructing barricades.
- Constructing signs.
- Lights.
- Directing traffic.

Maintenance work:
- Storing premixed material.
- Patching oil.
- Seal-coating.
- Picking up, remixing and laying down.
- Sanding rich spots.
- Cleaning out culverts.
- Shouldering and dressing up.

Personal expenses of crew:
- Room and board.
- Transportation.

Watching property:
- Night watchman.

Engineering and supervision:
- Engineering.
- Supervision.
- Testing.
- Accounting.
- Staking off.
- Personal expenses.
- Car expense.
- Miscellaneous engineering expense.

Costs.—A complete account of the season's work shows the following costs per square yard:

Item	Cost per sq. yd. cents	Per cent
Material	9.37	51.21
Preliminary work	1.08	5.90
Oiling	1.85	10.09
Processing	3.54	19.38
Protecting traffic	0.28	1.53
Maintenance work	0.64	3.50
Personal expense of crew	0.04	0.18
Watching property	0.10	0.57
Engineering and supervision	1.40	7.64
Total	18.29	100.00

The season's work was 37.346 miles or 426,963 sq. yd. The cost was $78,086.10, which amounts to $2,090.88 per mile or 18.29 ct. per square yard.

Experience of the Past Season.—An interesting experience during the past season occurred on Federal Aid Project No. 149-A, which was a 4¾ mile project east of Deer Trail. This oiling was not started until late in October. On the morning of Oct. 28, the weather was threatening and there remained a stretch of 1¾ miles to go. One mile of this was mixed ready to lay down, ¼ mile was partly mixed, and ½ mile did not have the oil on it.

Two mixing crews with three tractors were on the job. One tractor crew laid down the mile which was already mixed and the other tractor crew mixed the ¼ mile section. The oiling crew distributed the oil on the ½ mile section, completing this operation about the time the first tractor crew finished laying down the mile section.

The first tractor crew then mixed the ½ mile section and the distributor and three booster trucks were used to compact the mile section which had just

been laid down. About the middle of the morning the second tractor crew completed and laid down the ¼ mile section which was then compacted by the trucks. The second tractor crew moved to the ½ mile section and helped the first crew mix.

At two o'clock, just as the ½ mile section was mixed, a light rain fell. This section was laid down in a light rain and the trucks were put on it the minute it was down. After compacting for an hour the trucks were taken off the road. A few minutes later it was raining hard. The rain turned to snow which reached a depth of at least a foot.

If trucks had not been used to compact the processed material the whole 1¾ miles which was laid down that day would have been lost. This section, with the exception of two spots, each a square yard or two in area, is in good condition today. Reference is made to the wearing quality or durability of this road because compaction under these conditions necessarily left a rough surface.

The question of using trucks regularly to speed up compaction is one that might naturally be raised. This is not recommended except in emergencies because compaction is so fast that the maintainer cannot keep the surface smoothed sufficiently to prevent a rough surface. The trucks could be used to advantage in assisting the regular traffic especially on the edges of the pavement where traffic does not travel. Of course the edges can be compacted by the maintainer if progress is not too rapid.

While experience of the past season has demonstrated that under proper conditions of both subgrade and method of processing, a good road can be constructed by the surface-mixing method, it is easy to construct a poor road by this same method.

As everyone who has had experience with this type of road had advocated, an oil road can not be successfully constructed on a wet subgrade or with appreciable moisture in the material which is to be processed. The writer is certain that all failures which he has observed during the past season may be attributed to excess moisture in some form. An interesting instance of this kind occurred on the Ingleside project. On this job the aggregate was stock-piled in a ridge along the edge of the road. When this piece of road was processed the aggregate was dry and the subgrade appeared to be dry. It has since been demonstrated that moisture had accumulated during the months which the aggregate was stock-piled and that this moisture was still present in spots when the oil was laid down. On the edge of the oiled portion of the roadway where the gravel had been piled there was a strip 1 or 2 ft. wide which rolled badly. Several pieces of this had to be taken up, dried and relaid.

One thing which has been brought out is the tendency of water to get under the edge of the oiled section and cause it to ravel. In order to prevent this, it is necessary to give the shoulders a sharp slope away from the oiled section so that the shoulders are almost valueless as far as driving upon them is concerned.

Wyoming is said to be experimenting on carrying the oiling across the shoulders to the top of the slope. Perhaps this will overcome one of the greatest drawbacks to successful oiled roads.

The writer certainly does not believe that satisfactory results can be obtained with oiled roads where the water table is close to the surface. Or rather he does not believe it is possible to oil this kind of road successfully without first building it up several feet. If it is remembered that the oiled road is not a cure-all and also that it is not a permanent road and will need more or less constant maintenance, there should be a great future for this type of road in Colorado. It will permit the construction of a far greater mileage than is possible with concrete and it will give relief to communities where paving is now impracticable. It will still be a paying proposition to construct oiled roads even though at some later date many of them are replaced by concrete.

Zoning Progress in the United States

Zoning ordinances were in effect in 856 cities, towns, villages and counties throughout the United States on Jan. 1, 1930, according to a recent report of the Bureau of Standards, Department of Commerce, based upon survey made by its division of building and housing.

These zoned municipalities contain more than 39,000,000 people, or a number equal to three-fifths of the urban population of the United States. Zoning authority has been conferred upon municipalities in 47 states and the District of Columbia, while in the 48 states, Washington, cities of the first class have authority to enact zoning regulations under general home rule provisions of the state constitution.

The report shows that during the past two years 183 municipalities and counties adopted zoning ordinances, while 127 others either amended or revised zoning ordinances previously adopted. During the same period five cities, namely, Cleveland, Dallas, New Orleans, Spokane and Youngstown, each having over 100,000 population, were zoned, making a total of 60 of the 68 largest cities having zoning ordinances in effect.

An examination of the 183 zoning ordinances adopted during the past two years shows that 130 are comprehensive in scope, and of the 127 revised and amended ordinances 108 are comprehensive. There is a constant increase in the percentage of comprehensive measures over those of other types.

The states rank in the following order as to the number of zoned municipalities: New York, 143; New Jersey, 104; California, 80; Illinois, 78; Massachusetts, 68; Pennsylvania, 57; Ohio, 46; Michigan, 38; Wisconsin, 30; Kansas, 23; Indiana, 21; Connecticut, 18; Iowa, 14; Florida, 13; Missouri and Virginia, 10 each; Rhode Island, 9; Colorado and Oklahoma, 8 each; Nebraska, 7; North Carolina, 6; Georgia and North Dakota, 5 each; Alabama, Maryland, South Dakota, Tennessee, Texas and Washington, 4 each; Idaho, Minnesota, New Hampshire, Oregon and Utah, 3 each; Arizona, Arkansas, Kentucky, Louisiana and Maine, 2 each; and Delaware, District of Columbia, Mississippi, Nevada, South Carolina, and Wyoming, one each.

The report shows that legislation during the past two years took the form of constitutional amendments; general zoning enabling acts, charters and charter amendments; home rule amendments; regional, county and township zoning; and special enactments of various sorts, as for example the control and the location of gasoline stations.

Nine legislatures based their zoning enactments during 1928 and 1929 either in whole or in part upon the text of "A Standard State Zoning Enabling Act," issued in 1923 by the Advisory Committee on City Planning and Zoning and published as Bureau of Standards publication BH-5. There are now 35 states that have used the Standard Act in the enactment of 54 zoning laws.

Copies of the "Survey and Zoning Laws and Ordinances Adopted During 1928 and 1929, may be obtained by writing the division of building and housing, Bureau of Standards, Washington, D. C.

Italian Government Approves Award of Contract for Padua-Venice Autostrada.—Official approval of the awarding of the contract for the building and supervising of the autostrada Padua-Venezia to the Societa' Anonima of Autostrade Venice-Padua is given by Royal Decree-Law published in the official Gazette of January 30, 1930. The length of the road is 16.38 miles. The headquarters of the Societa' Anonima delle Autostrade Venezia-Padova are in the Istituti Federali della Cassa di Risparmio delle Venezie, Venice.

Trans-Isthmian Highway.—During the dry season of 1929 (January to May), engineers of the Panama Canal, divided into two field parties, completed a survey and location of a highway across the Isthmus of Panama. The length of the road is 46 miles; highest altitude reached 482 ft. above sea level; number of bridges required, 46, number of culverts per mile, 10; estimated cost, $6,000,000.

Maintenance of Oil Treated Roads

Experiences of the State Highway Department of New Mexico

THE method and costs of oiling crushed gravel and crushed rock surfacing in New Mexico were described by Mr. E. B. Bail, Construction and Maintenance Engineer, New Mexico State Highway Department, in the October, 1929, issue of *Roads and Streets*. At the 1930 Highway Conference at the University of Colorado, Mr. Bail presented a paper dealing with New Mexico's experience with the methods and costs of maintaining these roads. His paper follows.

It must be recognized that maintenance costs rise or fall as they are affected by errors in design, construction defects, and amount and kind of traffic.

Errors in Design.—This factor affects oiled surfaces of highways which pass through irrigated regions at an elevation only slightly above the adjacent ground surface and where the ground water level is at or above the actual soil surface. New Mexico's first oil-treated road passes through a locality which conforms to the above conditions and the cost of maintenance is affected by the existing situation.

Another difficulty is an inadequate ditch system. Oiled surfaces must be protected from seepage water due to standing water which accumulates after a rain or snow. One oiling project, the Canoncito-Pecos forest road, is, at its highest point, 7,000 ft. above sea level. It is located in a rugged country, has numerous 6 per cent grades, and is entirely free from irrigation water. It presents excellent possibilities for side drain ditches.

Nevertheless, this project has been our second most expensive from the maintenance standpoint, because the design of this road provided for a narrow type of side ditch. Furthermore, on account of inadequate slopes in clay cuts, there is sloughing due to frost and rain, so that the ditches become clogged and little ponds form. The water from these ponds seeps into the adjacent shoulders and under the oiled surface. The subgrade is softened and becomes unstable. The impact of traffic over the softened subgrade causes a depression in the oiled surface and in a short time disintegration has occurred.

Construction Defects.—The principal construction defect which directly affects maintenance is one of which we are aware, but which we are unable to avert or eliminate; namely, water in the mixed material.

New Mexico's heaviest rains occur during the construction season. It has not been possible to complete a project without having some part of it well-soaked. Repeated turning and disc-harrowing have been an effective means of drying, but inevitably there are sections where, due to a larger percentage of fines, the mix has not dried as rapidly as elsewhere. Shortly after the road has been completed these wet spots develop into dark, soft streaks, which later corrugate and roll.

Wagon Traffic.—Wagon traffic causes no difficulty on most of our oiled roads, but in some localities this traffic is very troublesome.

Probably 75 per cent of the wagons are of the old narrow-tire type. The drivers insist on keeping one wheel on the edge of the oiled surface and this means that one of the shod horses travels on the oiled edge. As a result of this the surface which has been formed by automobile traffic is loosened and broken to pieces. Rain and melting snow penetrate this broken surface and its destruction is soon completed. It seems unfair that this type of traffic, which is only a small percentage of the whole and which contributes nothing in the way of financial support to the highway, should be permitted to do so much damage and thereby greatly increase the maintenance costs. However, this is an evil which must be endured.

Maintenance Methods.—Regardless of which of the foregoing factors is responsible for need of maintenance, the methods of repairing the surface are much the same.

On the road which passes through the irrigated locality there is a stretch where most of the oiled surface is at the level of, or below, the adjacent ground level and where wagon traffic is heavy. Shoulder breaks and pot holes caused by ground water penetrating clay pockets under the surface require constant patching. When a saturated clay pocket forms under the oiled surface, we find that we must dig it out, for it will never cease to give trouble unless it is removed. Some of these holes are backfilled with gravel, or, if gravel is not readily available, sand may be used. The surface is then brought to grade with premixed oiled gravel. Other holes have been surfaced with gravel, which is then penetrated with Bitumuls, an emulsified asphalt which can be applied cold. The same methods are followed in patching shoulder breaks.

The premixed oiled material is prepared by mixing in a small concrete mixer or by hand on a platform. The mixer is just as economical and satisfactory for this type of work as for concrete mixing and it has the same advantages over hand mixing.

Bitumuls, sprayed on with a hand force pump and followed by a top dressing of sand, is used for patching raveled spots. This makes a very good armor and seldom has to be renewed.

On the forest project above mentioned, where the ditches were filled with muck, several hundred dollars were spent on cleaning, widening and deepening the ditches. Crushed gravel was mixed in a concrete mixer with 72 per cent asphaltic oil having a viscosity of 122. Clay pockets which had become evident were dug out and the surface over the greater part of eleven miles was widened from the original width of 18 ft. to an average of 20 ft. This high viscosity oil could be thoroughly mixed in approximately four minutes during ordinary summer weather; however, the mixture was sufficiently stiff when placed and rolled to permit the use of narrow-tire wagons without cutting. It also stood up well under shod horses. At summer temperatures this oil was heated to approximately 150° F. During winter this type of oil could not be used if there was an appreciable amount of 200-mesh material present; and it is very desirable that from 6 to 12 per cent of this fine material be used. This type of oil cost $1.25 per barrel, f.o.b. refinery.

Seal Coating.—Some projects, after they had been in use for six or eight months, indicated by the raveling of an otherwise well-compacted surface that the mix had been too lean. East of Deming there was a lean section about 15 miles long.

It was decided to armor-coat this section, using Bitumuls on part and road oil on the remainder with a dressing of pit-run sand. Both oil and Bitumuls were applied with pressure distribution. Sand was spread from dump trucks by slightly opening the end-gates. The sand was damp and did not spread so well, so it was necessary to complete this operation by hand brooming. Both sections look well at present and it is not known which is the better.

The Bitumuls treatment cost a little over $180 per mile and the fuel-oil dressing cost slightly over $130 per mile.

Cost of Maintenance.—At this time it is not possible to estimate what the average yearly cost of maintenance per mile should be. Our first project has cost $488 per mile per year to date. However, it is a victim of error in design, having been placed on a low-lying road through a water-logged, irrigated section. Nevertheless, it has been economical, for it has provided a smooth, dustless riding surface. All the gravel originally placed on the road is still in place, and, in addition to the above advantages, it has cost no more to maintain than the gravel surface which it replaced.

As nearly as can be determined, the average cost per mile per year to date has been about $175.

Drainage in Road Construction

Movement of Water in Soils—Drainage and Subgrade Treatment in Practice

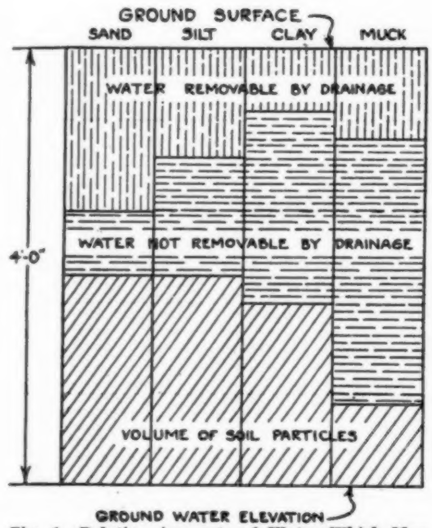


Fig. 1—Relative Amounts of Water Which May and May Not Be Removed by Drainage in Different Soils

THE U. S. Bureau of Public Roads, assisted by the U. S. Bureau of Chemistry and Soils, and other cooperating agencies, has progressed in its subgrade investigations to a stage indicating the practical value of subgrade information with respect to the design and construction of roads. Several phases of the investigation were outlined in a paper prepared by C. A. Hogentogler, Senior Highway Engineer, Henry Aaron, Junior Civil Engineer, and F. A. Robeson, Junior Highway Engineer, all of the U. S. Bureau of Public Roads, and presented at the 1930 convention of the Association of State Highway Officials of the North Atlantic States. That portion of the paper relating to fundamental facts with respect to design of drainage systems is reprinted below.

Movement of Water in Soils

In the design of the road drainage system certain fundamental facts should be remembered. They are:

1. Soil moisture may be of two kinds: (a) capillary moisture or that forced through the soil due to the surface tension of water, and (b) gravitational water or that which flows through the soil due to the force of gravity.

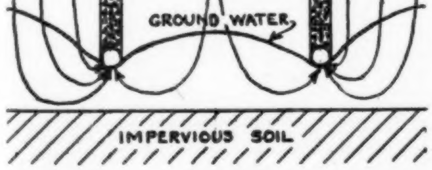


Fig. 2—Movement of Water Through Soil, According to W. J. Schlick

2. Drains serve to remove only the gravitational water from soils.
3. To completely intercept seepage in a porous soil layer the drains must extend in depth to the impervious under soil.
4. No flow of capillary moisture occurs in soils unless the capillary equilibrium is destroyed.
5. Water can not enter soil pores containing air until the air is forced out.

Relative Amounts of Water Removable and Not Removable by Drainage.—Figure 1 shows the relative amounts of soil, gravitational water and capillary moisture apt to be contained in a 4 ft. depth of four different soils at maximum saturation.

According to this figure drains which serve to lower the ground water elevation from the surface of the ground to

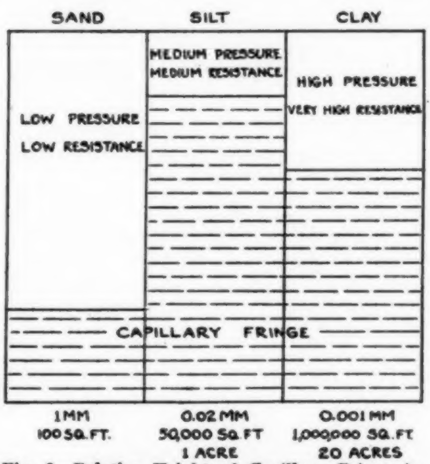


Fig. 3—Relative Height of Capillary Fringe in Different Soils

a depth 4 ft. below the ground surface serve to take out most of the water contained in the sand, slightly less than one-half of the water contained by the silt and but a small proportion of the water contained by either clay or muck.

Movement of Water.—Figure 2 illustrates that particles of water which enter the ground surface do not flow diagonally toward the drain but drop down vertically, until they meet the ground water flowing along the impervious soil layer. This shows why a drain to intercept seepage must extend in depth to the impervious layer; otherwise the water is apt to skim under the drain making the drain ineffective.

Detrimental Capillary Rise.—Figure 3 illustrates why detrimental capillary rise is especially important in silts. This capillary rise is dependent upon two factors: the capillary pressure, which tends to force the water up into the soil and the frictional resistance offered by the soil pores to the flow of water. That pressure and also the

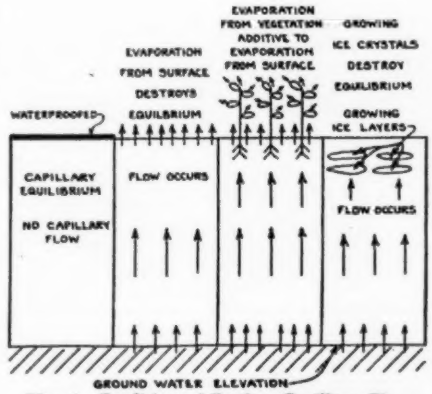


Fig. 4—Conditions Affecting Capillary Flow

resistance to flow increase as the size of the soil particles decreases. Consequently the maximum detrimental rise is caused by a proper combination of these two forces. In sand both the capillary pressure and the resistance to flow are low, in clay in contrast both force and resistance are high. Silts possess the proper combination of force and resistance to flow productive of detrimental rise. Detrimental frost heave therefore is confined primarily to silts. Softening of consolidated clays is apt to be due to water entering the top of the subgrade and not from the bottom.

Conditions Affecting Capillary Rise.—Figure 4 illustrates factors which influence the rate of flow of capillary moisture. Capillary equilibrium must

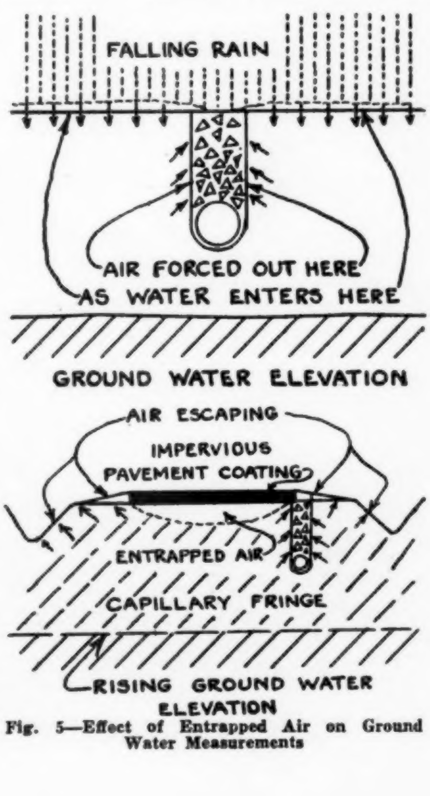


Fig. 5—Effect of Entrapped Air on Ground Water Measurements

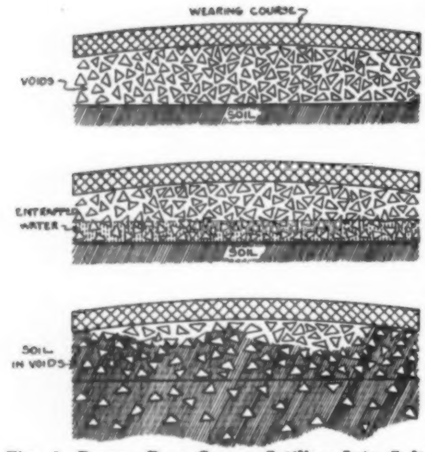


Fig. 6—Porous Base Course Settling Into Soft Soil

be disturbed before flow occurs. This equilibrium may be disturbed by evaporation, frost action, the presence of vegetation and a change in ground water elevation.

Influence of Air on Flow of Moisture.—Figure 5 illustrates how the presence of air influences the flow of moisture in soils. On the left the falling rain causes the entrapped air to be forced out through the drain as the rain water enters the ground surface.

On the right entrapped air under an impervious soil covering may interfere with the rise of capillary moisture. Also air escaping through the drain on the right may permit capillary moisture to enter that side more rapidly than on the left where there is no drain. This does not mean that drains are not effective for increasing the stability of subgrades. By intercepting seepage and disposing of water during thaws they are effective for preventing complete loss of stability in the subgrade. Nevertheless a slightly higher moisture content might occur where drains exist than where they do not.

Figures 1, 2, 4 and 5 were suggested by W. J. Schlick, in his report "The Theory of Underdrainage."

Drainage and Subgrade Treatment in Practice

The effect of trapped water is disclosed by F. V. Reagel, who found that gravel pavements 6 in. thick when constructed according to the feather edge method were equal in service to gravel

Fig. 7—Gravel Road on Minnesota Clay Soil. Photo Furnished by F. C. Lang

pavements 10 in. thick when constructed by the trench method. Thus 4 in. of gravel were required to compensate for the additional wetting of the subgrade due to water trapped in the trench construction.

How Entrapped Water Causes Damage.—Figure 6 shows how entrapped water is apt to cause both macadam foundations and base courses to fail. Above is shown the newly constructed base course. In the middle is shown water collecting in the pores of the base course. Below is shown the soil penetrating the base course and the stones of the base course sinking into the soil. The cause of stone particles working down into the soil has gener-

Fig. 8—Gravel Road in Minnesota Placed on Same Soil as Shown in Fig. 7, but with a Bituminous Treatment on Subgrade. Photo Furnished by F. C. Lang

ally been attributed to pressure, wheel loads, etc., exerted on top of the pavement. Evidence is now available, however, that the stone fragments due to their own weight may settle down into the subgrade soil during thaws. A porous base course, you understand, will not heave due to frost action; the

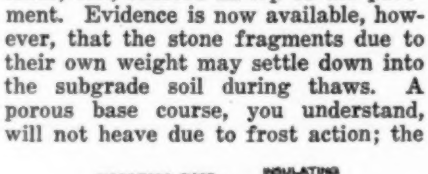


Fig. 9—Subgrade Preparation for Flexible Pavement on Clay or Silt

Fig. 10—Drainage in Sags

difficulty is to keep that base course from settling into the undersoil.

Bituminous Treatment of Subgrade.—Figure 7 shows a gravel road on a gumbo soil in western Minnesota during the spring thaw. Particles of the gravel surfacing have been found to penetrate the soil as much as 3 ft. maximum and commonly to a depth of 18 to 24 in.

Figure 8 shows the same type of gumbo soil in the same location and at the same season as referred to in Fig. 7, but in this case the soil has received a bituminous treatment and

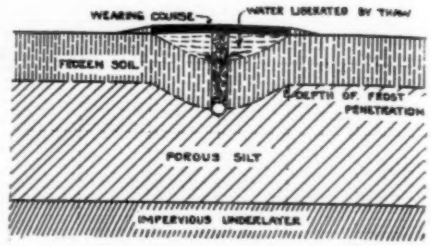


Fig. 11—Center Trench Installation for Frost Boil Areas

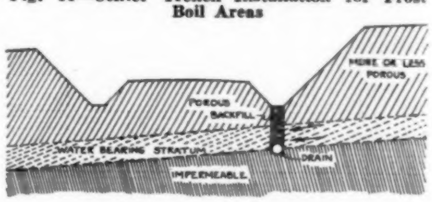


Fig. 12—Side Trench for Intercepting Hydrostatic Water

then been covered with a thin layer of crushed gravel. The effective thickness of this surface during the first winter would not be more than about 1 in. Because of the remarkable performance of this blotter type of construction on highly plastic gumbo soils under the worst conditions of freezing suffered in the United States, we believe that treating the soil with bituminous material and covering with a thin layer of granular material as shown in Fig. 9 will serve to prevent the failure of both porous base courses and macadam foundations laid as clay soils. In addition all sags should be drained as suggested by Fig. 10.

In silt soils water rising from below due to frost action is apt to prove troublesome, therefore the treatment discussed above must be supplemented with drainage to either lower the ground water elevation or to dispose of water liberated by thaws.

Drainage for Frost Boil Areas.—Figure 11 shows the type of drainage used with good effect in Minnesota. Due to the presence of snow on the shoulders and in the field adjacent to the road and its absence on the road surface and to possibly other factors related to the road surface, the frost is apt to penetrate deepest under the road surface. Also during thaws water is apt to be liberated first under the center of the road surface. This water

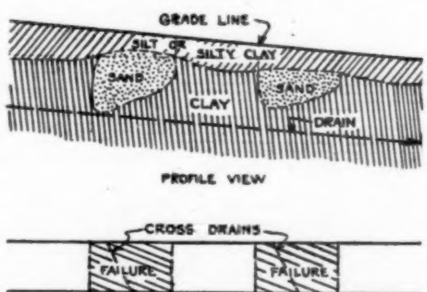


Fig. 13—Side and Cross Trenches for Draining Same Pockets

can not penetrate the frozen soil to reach side trenches. A center trench, however, serves to reduce the moisture content of the soil before freezing and provides an unfrozen channel through which water liberated by thaws may reach the unfrozen and porous under soil. It is possible that either very deep side trenches or thick base courses are apt to prove more beneficial for preventing cracking in concrete pavements than any system requiring narrow drains to be placed under the pavement proper.

Figure 12 suggests a scheme for intercepting hydrostatic water and Fig. 13 suggests a scheme for draining water pockets.

No Change in Vitrified Paving Brick Types and Sizes

At the annual meeting of the Permanent Committee on Simplification of Varieties and Standards for Vitrified Paving Brick held in Washington, April 1, 1930, the variety survey of the past year was examined with the result that no changes in recognized types and sizes were made for the ensuing year.

These six varieties comprised 87 8/10 per cent of the total shipments of 1929.

Recognized sizes for 1930 are as follows: Wire-cut lug brick (Dunn) 4x3½x8½ in. and 3x3½x8½ in., repressed lug brick 4x3½x8½ in., plain wire-cut brick (vertical fiber lugless) 2½x4x8½ in., 3x4x8½ in., and 3½x4x8½ in.

Every year the U. S. Department of Commerce makes a survey of the shipments of paving brick for the preceding calendar year. The data received are compiled in a report which is prepared by the National Paving Brick Manufactures' Association for the Permanent Committee on Simplification of Varieties and Standards for Vitrified Paving Brick which meets near the first of April annually in Washington, D. C. On this committee are represented the U. S. Bureau of Public Roads, U. S. Bureau of Standards, American Society of Civil Engineers, American Society for Testing Materials, U. S. Chamber of Commerce, American Ceramic Society, American Society for Municipal Improvements, American Association of State Highway Officials, the National Paving Brick Manufacturers' Association, and the U. S. Department of Commerce. The committee's recommendation of "recognized" types and sizes is based on the report of shipments.

The principal benefits of simplification result in reduction of "stocks" sizes at plants, reduction of storage space for special stock at plants, anticipation by manufacturers of sizes and types, elimination of special machinery and equipment in production, reduction in labor production costs, elimination of an element of uncertainty in design, instrumental in the adoption of "rattler" test standards for various sizes and helpful in standardizing engineering specifications for the vitrified brick type of pavement.

Engineers, in general, have adopted the recognized sizes and types as is evidenced by the fact that, in 1929, they constituted 88 per cent of all shipments. At the same time, freedom in the development of the paving art has not been throttled, as the list was increased one year to include a type that, because of engineering merit, had shown a steady increase in shipments.

Committee members in attendance at the meeting just held in Washington were L. W. Teller, representing the U. S. Bureau of Public Roads (proxy for P. St. J. Wilson); Professor T. R. Lawson, representing the American Society for Testing Materials; Colonel R. Keith Compton, representing the American Society of Civil Engineers; O. W. Renkert, representing the American Ceramic Society; F. L. Raschig, representing the American Association of State Highway Officials (proxy for R. N. Waid), and G. F. Schlesinger, representing the National Paving Brick Manufacturers' Association, and H. R. Colwell, representing the Division of Simplified Practice, U. S. Department of Commerce.

Progress on the Pan American Highway in Panama

Panama is making progress in the construction of its part of the Inter-American Highway. The Secretary of Public Works is hopeful that by next February there will be completed a continuous road over which automobiles can comfortably travel all the way from Panama City to the Costa Rican border, a distance of at least 450 kilometers (280 miles). At the present time there are two gaps in this highway. The first, between Sona, Veraguas Province, and Remedios, Chiriqui Province, is 70 kilometers (43 miles) long. Construction between these roads has been begun, and, according to the engineers in charge, the hardest part of it is done. A 320-ft. reinforced concrete bridge, costing around $100,000, is being constructed on this section. The second gap is the last stretch between El Volcan and the Costa Rican frontier, about 60 kilometers (37 miles).

After next February, according to the Automotive Division of the U. S. Bureau of Foreign and Domestic Commerce, if the work progresses as is expected, it will therefore be possible to motor in the dry season to the refreshing coolness of the Chiriqui hills —over a fairly good macadam road from Panama City to Santiago, and the rest of the way to the Costa Rican frontier over a well graded dirt road. During the rainy season the torrential downpours will in all probability render the dirt road section impassable. It is planned to hard surface the entire highway eventually.

Highway Progress in New Brunswick During 1929

The most extensive highway program ever undertaken in New Brunswick was carried out during 1929, according to the annual report of the Chief Highway Engineer of the Province, quoted in a report from Vice Consul Frederick C. Johnson, published by the Automotive Division, Department of Commerce.

The road system now includes 1,367 miles of main trunk highways, which link the various cities and towns and connect with the main highways of the neighboring provinces and the State of Maine; 3,268 miles of secondary trunk highways, which afford direct connection between villages or towns or connect these municipalities with the main trunk highways; and 7,187 miles of branch or by-roads of purely local interest.

During the year 212 miles of main trunk roads and 1,138 miles of secondary and branch roads were reconstructed, while 190 miles of main trunk and 1,327 miles of secondary and branch roads were improved.

Expenditures during the past year are summarized as follows: Ordinary roads, $620,696.50; municipal roads, $112,144.71; patrol, $572,506.68; "permanent" main trunk roads, $1,358,695.72; "permanent" secondary and branch roads, $3,131,701.25; a total of $5,795,744.86.

Montreal Harbor Bridge Opened

The Montreal Harbor bridge was officially opened on May 24. The structure is two miles long and connects the the city of Montreal, Que., and the other municipalities on the north side of the river with the growing suburban towns south of the St. Lawrence, forming part of the greater metropolis. The new bridge will link up with the important highways entering Montreal from the province of Quebec to the south and also with the highways from the United States.

To accommodate the traffic which will pour in and out of the city over the new bridge, it has been necessary to provide guard-rail enclosures for entrance and exit to accommodate eight streams of vehicular traffic besides the right and left pedestrian lanes. These facilities have been provided at both ends of the bridge together with suitable toll stations and all that remains before the bridge is thrown open to the public is the completion of the process of inspecting the structure and the approval of the federal government of the tariff of tolls which has been set by the Harbor Commissioners.

Protection of Railway Grade Crossings

Report Based on Careful Study of Conditions Surrounding Grade Crossings and Highway Intersections

FIVE simple rules for the guidance of motorists at railway grade crossings, and through which it is hoped to reduce the list of fatalities and accidents, are recommended by the Committee on Protection of Railway Grade Crossings and Highway Intersections of the National Conference on Street and Highway Safety in its report presented to the third National Conference on Street and Highway Safety, which was held in Washington on May 27, 28 and 29.

The five rules are:

1. Slow down or stop.
2. Listen and look both ways; when one train passes, another may be coming.
3. Shift to lower gear if necessary to prevent stalling on tracks.
4. Don't try to beat a train over the crossing.
5. Be doubly careful at night or on strange roads.

The committee strongly urges the removal of all obstacles to clear view at crossings and intersections, together with clearly discernible and easily understood signs and signals that warn the approaching motorist of the presence of the crossing.

Emphasis is placed by the committee on the necessity, however, of prudent conduct in approaching and passing over grade crossings, particularly when on strange roads, or in foggy weather, or at night.

The report of the committee is based on a careful survey of the conditions surrounding grade crossings and highway intersections, and the hazard and frequency of accidents. It is pointed out that while new grade crossings should be kept at a minimum and existing crossings separated or eliminated as rapidly as possible, grade separation cannot be depended upon for the ultimate solution of the matter.

What the Survey Shows.—In the survey of grade crossings, the committee finds:

1. Accidents at grade crossings are causing 8 per cent of the annual number of highway deaths, estimated at 31,000. Accidents at railway grade crossings for the last three years have averaged 5,781 a year for the last three years, of which 4,399 were vehicles struck by trains, 1,272 were cases where automobiles ran into the side of trains, and 110 involved the occupants of other vehicles or pedestrians on crossings.

2. While more than $60,000,000 a year for railway grade crossing elimination has been spent in the last three years, the total number of grade crossings, as well as highway intersections, is increasing, due to new highway construction. Separation of grades cannot be counted upon because of the financial cost to solve the problem. Establishment of uniform warning signs and signals, and uniform protective measures, and the education of highway users to prudent use of crossings, is the quickest and most certain remedy, in the view of the committee.

3. Reduction of physicial hazards at grade crossings, as well as at intersections, can be facilitated by the construction of practically level and smooth surfaces of road for a distance of 25 to 50 ft. on each side of the tracks, and the approach to the tracks on grades not exceeding 4 or 5 per cent, as well as the widening of the roadway at the crossings. Railway cars should not be left standing at or near crossings, nor other obstacles, including crops, trees and billboards, so located as to prevent a clear and sufficient view of approaching trains. The committee urges the placing of warning signs and signals in such positions as not to interfere with visibility of the highway users, and the adoption of colors that are easily and plainly discernible.

4. Of the 240,000 grade crossings in the United States, 87.8 per cent are dependent for protection on standard fixed signs. The trend of protection is toward visible automatic signals. A fair division of the costs of installment of automatic signals, as well as the elimination of obstacles to view, is practical and equitable means of facilitating the work of protection. Signs should be placed at adequate distances from crossings, not to exceed 450 ft., to give warning to motorists, while other signs should be placed nearer the crossings calling for a reduction of speed to safe and reasonable limits.

5. Careful study of the traffic flow and condition is necessary to properly protect the crossings by signs and signals, and determine the measures that are adequate for safety at each crossing. At crossings on heavily traveled highways, the responsibility of the motorist for prudence and caution is greatly increased. In addition, the committee urges the installation of wig-wag red light, or alternate flashing red light signals, at such crossings as a further safety measure.

6. Attention is called to the provisions of the Uniform Vehicle Code and Model Municipal Traffic Ordinance, laying down the fundamental rule against reckless driving at crossings, and providing that motorists must keep to the right, and obey the indications of stop-and-go signals, traffic officers, crossing watchmen or crossing gates. Public and school buses and vehicles carrying explosives or inflammables must stop.

7. Special attention of the police to the enforcement of laws and regulations at crossings and highway intersections is suggested. The recommendation is made that in examinations for licensing operators and chauffeurs, tests be made as to the working knowledge of the applicants of rules and regulations governing traffic at grade crossings and road intersections.

8. Despite efforts of the public authorities to eliminate hazards, provide ample warning and control measures, and enforce rules and regulations applicable to grade crossings and highway intersections, the public must be depended upon for voluntary compliance with the rules of proper conduct at such points. The committee says it is of fundamental importance that all laws, regulations, traffic control measures and protection safeguards should be conformed to by the public.

Grade Crossing Accidents Summarized.—In going into the accident situation, the committee gives the following summary (Table I) of highway grade crossing accidents on all steam railroads, and based on statistics of the Interstate Commerce Commission:

Findings of Committee.—In an analysis of the figures and statistics relating to the grade crossing accident situation, the committee makes these findings:

Table I

	1926	1927	1928	1929
Total accidents	5,862	5,596	5,752	5,912
Total fatalities	4,291	2,371	2,568	2,458
Total non-fatal injuries	6,991	6,613	6,666	6,804
Total fatalities and injuries	9,482	8,984	9,234	9,289
Fatalities caused by trains striking, or being struck by trains:				
Pedestrains	293	299	299	307
Passenger automobiles	1,766	1,690	1,820	1,741
Motor busses	15	30	9	7
Motor trucks	281	254	336	337
Others (motorcycles, bicycles, trolley cars, etc.)	136	98	104	93
Vehicles or pedestrians struck by trains:				
Accidents	4,585	4,295	4,357	4,358
Fatalities	2,188	2,078	2,240	2,163
Non-fatal injuries	5,240	4,844	4,688	4,631
Vehicles or pedestrians collided with trains:				
Accidents	1,129	1,205	1,298	1,454
Fatalities	237	259	285	287
Non-fatal injuries	1,661	1,701	1,923	2,104
Miscellaneous grade crossing accidents:				
Accidents	148	96	97	100
Fatalities	66	34	43	35
Non-fatal injuries	90	68	55	69

1. The number of grade crossing accidents and fatalities has been nearly constant during the past four years. This is in spite of an increase of 20.4 per cent in motor vehicle registrations in the same period.

2. Although the recent trend in grade crossing accidents has been more favorable than that for general traffic accidents, the fact that approximately 2,500 persons annually lose their lives at grade crossings emphasizes the continuing importance and magnitude of the question of crossing protection.

3. For each fatality in grade crossing accidents, there were 3.65 non-fatal injuries, whereas statistics from other sources indicate that for all kinds of traffic accidents, the ratio is approximately 35 serious personal injuries to each fatality.

4. The proportion of accidents in which motor vehicles collided with the sides of locomotives or trains has increased materially. The ratio of fatalities to non-fatal injuries in such accidents, however, is about 1 to 7, while the corresponding ratio is about 1 to 2.2 in struck-by-train accidents.

5. Fatalities to occupants of motor buses indicates a decrease during the past three years, but these statistics relate to accidents on steam railroads only. If electric railways were included, the year 1929 would show at least 20 additional fatalities which resulted from a single collision between a bus and an interurban electric train, and no doubt there were other accidents of this character during the period covered by the tabulation. It should be noted that there were a number of serious bus accidents in the first four months of 1930, two of which alone caused more than 30 deaths."

Remedial Measures Discussed.—In the discussion of remedial measures in connection with hazards and the risk of accidents at crossings, the committee says:

The crossings that are being eliminated are mainly those where the greatest exposure occurs. The same is true of crossings at which protective devices are installed. Hence the aggregate hazard of unprotected crossings is being reduced more than the figures as to crossings eliminated and protected might indicate.

Expenditures by the railroads for grade crossing elimination have averaged more than $30,000,000 per year during the past three years. While figures are not available as to the total expended by the public authorities as their share in such work, it is known that this is generally in about an equal amount with the railway contribution. Thus the average total expenditures by the railroads and the public is probably averaging more than $60,000,000 per annum. The cost of elimination of an average grade crossing is not available, but it ranges from as little as $25,000 to as much as $500,000 or more.

A progressive policy should be carried on by the railroads and the highway authorities with respect to elimination. However, as there is a total of about 240,000 highway railway grade crossings in the United States it is obvious that the elimination of all of them by grade separation is economically impossible, at least for the immediate future. Grade separation cannot be counted upon as a principal solution of the problem. Grade separation projects should be carefully selected as to include those which will to the greatest degree reduce hazards and facilitate traffic movement at points of greatest traffic density.

Chief reliance must be placed upon measures for reduction of hazards at crossings remaining at grade, as follows:

The physical hazards at grade crossings to which attention should be directed are those arising from—

1. Layout and condition of the highway at and on the approaches to the grade crossing.

2. Obstructions of whatever character to clear vision from the viewpoint of the highway user.

3. Lighting conditions at the grade crossing and visibility of the train equipment as seen by the motor vehicle operator.

Principal Physical Hazards that Require Attention.—The following are the principal physical hazards requiring attention:

Approach grades—Highway grades adjacent to railroad tracks should be practically level for a minimum distance of 25 ft., preferably 50 ft., on each side of the nearest rail. Beyond those points, if feasible, the approach grade should not exceed 4 per cent for main traveled roads carrying a considerable amount of truck traffic and should not exceed 5 per cent for roads carrying principally passenger traffic. These should be considered as maximum grades and should be reduced whenever practicable.

Road surfaces at crossings—If the road is clear and unobstructed the width of the surface at the crossing should be as wide as the travelable portion of the shoulders. If there is an obstruction in the roadway the width of the roadway surface allowed for each possible lane of movement of the highway leading thereto (including the travelable portion of the shoulders) should be 2 ft. more per lane at the crossing than the allowed widths on the roadway. The highways should be widened for a distance of 100 ft. on each side of the crossing so that the outside lanes of the roadway shall be the same distance apart as they are across the railway crossing. That portion of the road surface which is located between the rails and between the tracks should be maintained in as smooth condition for travel as the adjacent road surface.

Sharp turns near crossings—Sharp turns should be avoided at crossings. If unavoidable on account of conditions that may exist, they should be kept as far as possible from crossings, and not less than 250 ft. A curve detracts the attention of the driver from the real danger at the crossing and should be far enough removed so there will be ample opportunity to observe approaching trains after the driver has rounded the curve. Existing sharp turns near crossings should call for a relocation of the highway so as to eliminate this added danger.

Major highway intersections near crossings—Intersections of major highway intersections should be at least 500 ft. away from a railroad crossing so as to permit the ultimate separation of grades with the railroad, as well as a separation between the two highways; all others not less than 250 ft.

Obstructions to view—The obstructions ordinarily encountered are: Steep banks, trees and shrubs, standing crops, buildings, parked vehicles, cars stored on sidings, and billboards. To promote safety the driver should be able to observe approaching trains while he is still far enough from the crossing to permit him to decide whether he may safely clear the intersection in front of the train or, if not, to let the train pass in front of him. If it is not possible to provide unobstructed view, obviously greater precautions must be taken to insure full warning to the driver of approaching trains. Billboards and signs other than official traffic signs should not be erected closer to the crossing than a point 150 ft. from the advance railway warning sign on the approach side.

Lighting conditions at grade crossings—Where adequate illumination of grade crossings is economically practical it presents definite advantage both in the illumination of the crossing itself, of vehicles on the highway, and of railway equipment on the tracks. Special care should be taken in installing lights at grade crossings that glare is not thrown into the eyes of vehicle operators approaching the crossing, and that the lights aid in the visibility of the crossing signs and signals instead of reducing their visibility by the elimination of contrast, or make less visible the headlight beams of approaching trains. Consideration should be given also to the visibility of rolling stock as affected by automobile headlights or by fixed lights at the crossing.

Safe Driving Practices.—In discussing the proposition of what constitutes safe driving practices and restrictions at crossings, the committee says:

Absolute regard for positive visible or audible signals warning that a train is approaching is a fundamental requirement of law and prudent practice. Many crossings are not equipped with such signals, and the highway user is responsible for exercising the greatest circumspection and caution in traversing any railroad crossing.

In its simplest form a grade crossing consists of a single track railroad, with both track and highway straight, on level ground, with no obstructions to a clear view in all directions. In daylight the vehicle operator familiar with the crossing can assure himself by looking in each direction that no train is approaching and that he can continue in safety.

However, in order that his observations up and down the track may be sufficiently thorough to see any approaching train, without undue diversion of attention from the road ahead, and in order that he may not jeopardize himself and other highway users by running at excessive speeds over grade crossings which can seldom be made as smooth as other portions of the highway, he should not in any case traverse grade crossings at a speed in excess of 30 miles an hour.

There are crossings at which, particularly at night, the only way to make sure that no train is approaching is to stop near enough to command a view up and down the tracks. The prudent driver will make it his rule to stop at such points.

Having assured himself that the way is clear, how will the safe driver proceed? One rule will hardly fit all cases. If he has not been compelled to stop, and the crossing is level and smooth, high gear will take him clear of danger in the shortest time. If he has come down to low speed, or has stopped, he must above all things avoid stalling his engine which sometimes occurs as a result of a sharp grade, an uneven crossing, or nervousness caused by the sudden appearance of an approaching train, and should go over the crossing in low or second gear.

If he has the misfortune to stall his engine on the tracks and cannot restart promptly, he should know that, as a last resort, he can generally, by going into low gear and holding his foot continuously on his self starter, let it drive the car forward off the track.

Highways over railroad yards, or the switching approaches thereto, have special hazards, and should be considered in establishing priority in grade separation programs. The safe driver will watch freight cars standing near the roadway, lest they be unexpectedly set in motion by a switch engine, and will not relax his vigilance until certain he is over the entire crossing.

Although pedestrians are the victims in grade crossing accidents in a relatively small proportion of such accidents, he has two basic precautions to observe: He must be sure before he crosses each track that the way is clear, and in the case of multiple tracks, he must not permit himself to be trapped in front of one train with nowhere else to go."

Laws and Regulations.—In discussing laws and regulations, and their enforcement, at railway grade crossings, the committee points out:

The Uniform Vehicle Code contains several provisions relating specially to railroad grade crossings. One of these is that operators of motor vehicles must keep to the right in crossing railroads. Another is the obviously necessary one that warning signals must be observed. The Uniform Vehicle Code requires that certain vehicles, such as street cars, motor buses, school buses, and trucks carrying gasoline or other inflammables or explosives, must stop at all crossings. This provision is particularly appropriate inasmuch as the operators of such vehicles have special responsibilities to the public, and should be skillful enough as operators to make quite unlikely that the vehicle will stall or run into danger in starting over the crossing.

In some states laws have been passed requiring all motor vehicles to stop at all grade crossings. Such legislation has been vigorously opposed by the motoring public, both because it causes congestion on busy highways, subordinates even the heaviest highway traffic to railroad traffic, forcing stops many times where there is no need for a stop, and because it can be seriously questioned whether stopping at every crossing, and then proceeding across at low speed, does not prolong the hazard and introduce the danger of stalling.

On the other hand, it is evident that there are many crossings at which the only safe course is to stop and see whether a train is approaching.

The National Conference on Street and Highway Safety has emphasized the importance of vigorous and impartial enforcement of all motor traffic laws. Enforcement is inadequate in many, if not most, states and communities, motorists and pedestrians make their own rules; practices are indulged in every day which invite accidents that are avoided only fortuitously. Undoubtedly in many cases the driver who brings himself and his companions to grief at the grade crossing has previously been guilty of many unpunished violations of the traffic laws and regulations. More rigid enforcement all along the line could be expected to reduce materially railroad grade crossing accidents.

Anaysis reveals that a large number of drivers do not heed the warning given by the flashing light signals, run through crossing gates, and even disregard the stop sign of the crossing watchman. Not infrequently they run him down and fatally or seriously injure him.

There could well be check-ups of motorist and pedestrian observance of signals at grade crossings. When a motorist crashes through a crossing gate, or dashes under one that is being lowered, he is violating the law in effect in many states. When a pedestrian goes under the gate he is doing the same thing. There seems to be a tendency on the part of police officers to wash their hands of railway grade crossings, and leave it entirely to railroad companies to meet the situation. Enforcement officers should give as much consideration to violations at grade crossings as at other points, cooperating with the railroad officials.

An effective aid in enforcement of traffic laws and regulations is undoubtedly the drivers' license laws with examination. Safe driving practice at grade crossings should be given a reasonable amount of attention in such examinations.

The committee points out that notwithstanding the efforts of the traffic authorities to eliminate hazards at crossings, the public in the main must be depended upon for voluntary compliance with the rules of prudent and safe conduct at such points. The committee says:

Statistics indicate that a large percentage of the accidents occur in broad daylight when there is a clear view of the tracks in both directions, and in no small number of cases the vehicle runs into the side of the train. It is obvious that neither laws nor enforcement are effective. There is need for continual effort to educate the public on these matters.

Such educational efforts should be directed not only to impressing motorists and pedestrians with the need for obeying the regulations, but also in making clear to them what are dangerous and what are safe driving practices.

It is of fundamental importance that knowledge of the laws, regulations, traffic control measures and proper practice be carried to all of the public, and to this end the principles stated in this report should be utilized as the basis for suitably prepared selections for presentation to the general public.

Road Work for British Unemployed.—Up to Feb. 28, 1930, the English Government had approved financial schemes for unemployment relief works estimated at $195,000,000, and to provide employment of 164,000 man-years. The figure man-years represents the estimated number of men who would be employed if all the schemes lasted a year. Schemes for highways include unclassified roads, $13,000,000, trunk road development, $50,000,000, five year road program, $68,000,000, a total of $131,000,000. Employment on the road schemes is put at 100,000 man-years, or at the employment rate of 100,000 men for one year.

Proposed Road Expenditures for Saskatchewan, Canada.—Nearly $7,000,000 will be spent on Saskatchewan roads this season, according to an announcement by the Minister of Highways, during the course of the debate on the budget in the legislature. The total of $6,852,386 is to be divided as follows: On trunk highways, $2,963,585; gravel surfacing, $3,373,801; sundry grading, $395,000; colonization roads, $120,000.

Economics of Highway Detours

An Outline of the Practice in Pennsylvania, Together with Data on Detour Maintenance Costs and on the Use of High Early Strength Concrete

By W. A. VAN DUZER

Assistant Chief Engineer, Pennsylvania Department of Highways

THE convenience of the traveling public is becoming an increasingly important problem to highway authorities. The extent to which this problem is solved is an index of the degree the department merits public confidence. The traffic detour is more important to the public than the problem of construction. Improved highway systems have become so extensive that standards of highway transportation in terms of economics have of necessity risen to heights where maximum traffic convenience is indispensable.

Conclusions.—An improved highway must be free from obstructions and involve the least possible traffic interruption. This requirement will be met by the application of greater refinements in matters of traffic service.

The costs and inconvenience of detours to the public should be more carefully studied and analyzed that they may be kept to a minimum, thereby permitting the engineer's plan of operations to be successfully defended. Detour costs are surprisingly large and are becoming better understood by the user of the road.

Highway departments can properly afford to reduce traveling inconveniences as economics permit, for nothing will meet with greater popular approval and assure greater support for further improvements as required to meet traffic demands.

When they become advisable, detours must be made safe and easy for traffic in all seasons and kinds of weather. They should be maintained so as to be as nearly equal to those of the main highways as possible.

Economic investigations many times will show it advisable to avoid the detour by accommodating traffic over construction work, particularly when the roadway is graded to 36 ft. or 40 ft. in width. This involves half-width construction which offers minimum inconvenience by the use of high-early-strength concrete as required to keep traffic moving, thereby avoiding economic losses because of traffic delays and inconvenience.

The time duration of the detour must be kept to a minimum. If the use of high-early-strength concrete will help, the economics of the individual problem should be carefully studied and applied.

Local improvements or repairs should never be allowed to obstruct traffic or require its detouring, except in cases of absolute necessity. In such a case the duration of the inconvenience should be held to a minimum.

Intersecting highways, improved or unimproved, should be obstructed for as short a time as possible during the highway improvement. This also means that proper and fair consideration should be given to the inconveniences of local communities and residents along the road while under construction with the purpose of avoiding such inconvenience as far as possible.

Direction of Traffic Signs.—For several years the Pennsylvania Department of Highways has laid out a detour map upon the construction drawings giving the length and type on detour and the location of direction signs such as shown on Fig. 1. This map can not be prepared unless the engineer makes a detail study of the problem, and furnishes the information regarding the number and kind of signs required. It places the signing on an engineering, rather than a hit or miss, basis. I do not know of anything more discouraging to a motorist than to endeavor to travel a detour inadequately or improperly signed. We will grant that this principle is ele-

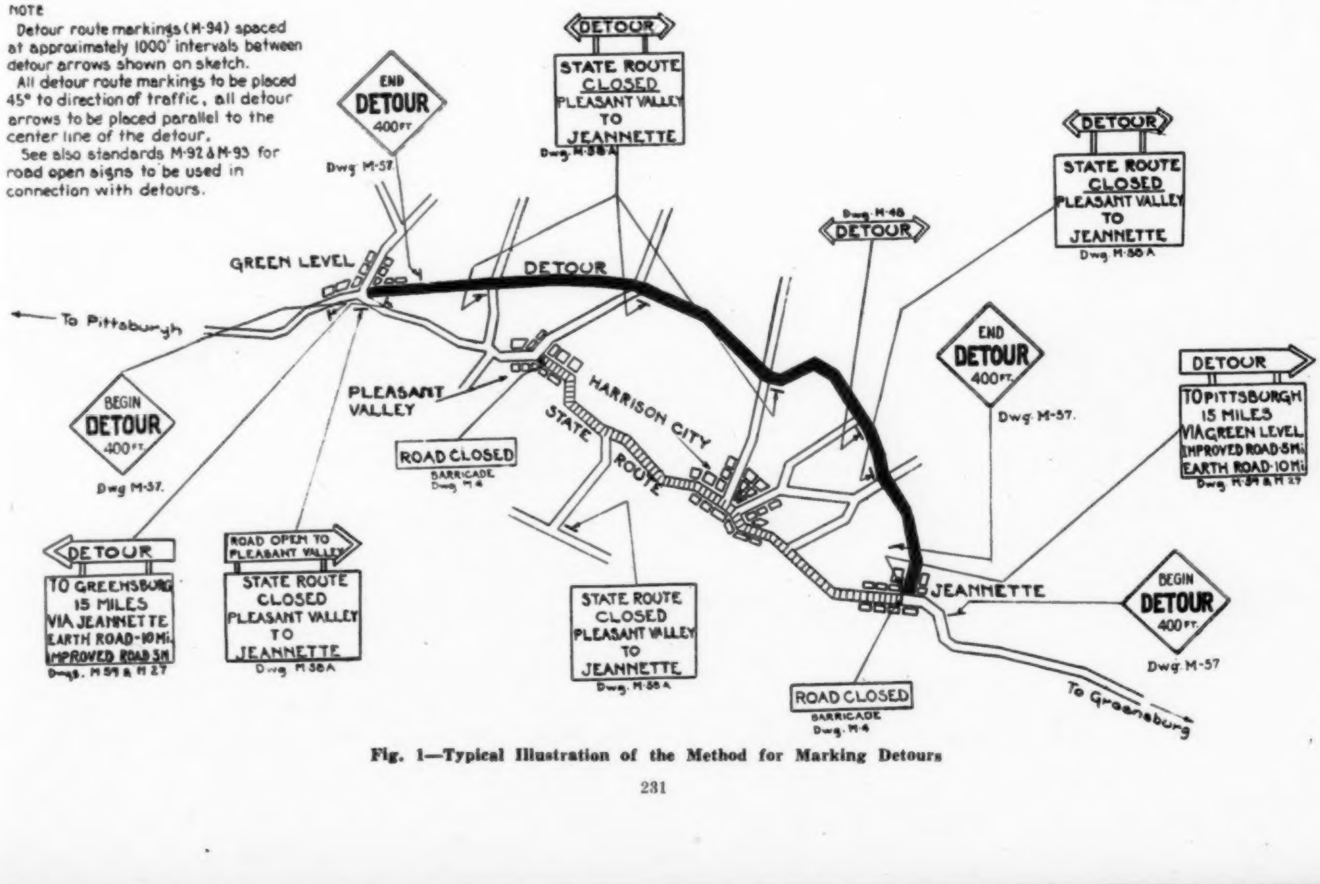


Fig. 1—Typical Illustration of the Method for Marking Detours

mentary, but believe that it needs continual emphasis.

We have adopted the same signing for detours as is found on the main highway routes. That means that the same type of signs are used and maintained. The preferable sign should include the number scheme as recommended by the American Association of State Highway Officials. Proper and effectively placed warning and danger signs should be erected and maintained in accordance with uniform and standard practice found on the main highway.

Figure 2 shows the sign erected at the beginning of the detour. Figure 3 is another form of sign used. The sign letters are of sufficient size so an automobilist has no trouble in reading them. Figure 4 is the arrow used at road intersections. Figure 5 shows the number system in marking the detour of U. S. and state numbered routes. Figure 6 is the standard method of marking the beginning, and Figure 7 is the standard marking denoting the end of detour. These signs were also recommended by the Association of State Highway Officials. A tour Bulletin is issued weekly by the Department of Highways showing location, length of detour and half-width construction.

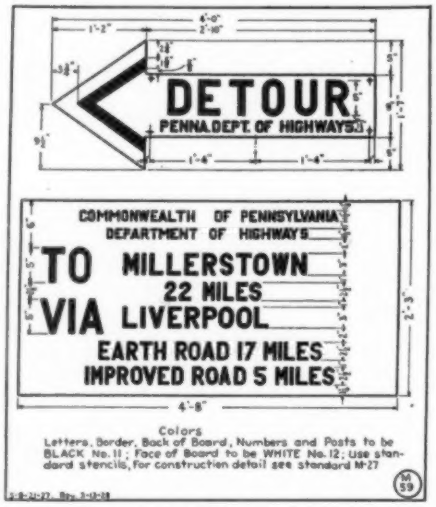


Fig. 3—Standard Detour Sign

Detour Lengths and Costs.—We find that the average length of detour in Pennsylvania for the years 1928-9 was 2.6 miles per mile of construction. The total number of miles of detours maintained was 1,252 at an average cost of over $286.00 per mile. In many cases the cost of maintaining a semi-improved detour exceeds that of an earth detour. An improved detour may have reached nearly its economic load limit when carrying its normal traffic with the result that the additional traffic due to detour often renders its maintenance cost very high. Taken as a State wide proposition, the average daily detour traffic in Pennsylvania in 1929 was about 825 cars per day.

Car Operation Costs Over Detours.—It is possible to show quite closely the cost of car operation over a detour mile. Such costs cover three main items in addition to maintenance cost of the detour.

	Passenger Cars	Trucks	Approximate 86% Passenger 14% Trucks
Fixed Charges:			
Depreciation, interest, license, insurance, garage....	$0.0533	$0.0587	$0.0540
Operating Cost:			
Gas, oil, tires, maintenance	.0383	.0825	.0445
Time loss	.0333	.1250	.0459
Total charges	$0.1249	$0.2662	$0.1444
		Say	.14

It is apparent that the sum of the three items will cover all operation costs, including time loss or delays, for any given reason. For this discussion, we believe sufficiently accurate results are obtainable by using a flat average charge of 9.5 ct. per mile. This charge is intended to cover everything having to do with the car, and we believe it is a conservative figure. We are not taking into consideration the known difference in operating costs on earth and improved roads. It would be difficult to show variable costs in this discussion, and in any event, they would not be very significant.

Four and five-tenths cents per car mile of operation appears to be a fair estimate of the value of time loss for the car occupants, including truck drivers. Time loss may, therefore, be expressed as being 4.5 ct. per car mile. We have now placed a measure of value on both car operating costs and time loss, the sum of which equals 14 ct. per car mile.

Detour Maintenance Costs. — The average cost per mile of detour is $286.00 in Pennsylvania. It can be assumed that the average detour duration period is 120 days. From these assumptions, the daily car mile detour cost is about $2.40. It is granted that a portion of this expenditure yields results in the form of a betterment of the road itself and, therefore, remains as such when the detour is abandoned. It is manifestly fair, therefore, to place a direct car mile maintenance charge against the detour at a daily rate of $1.20.

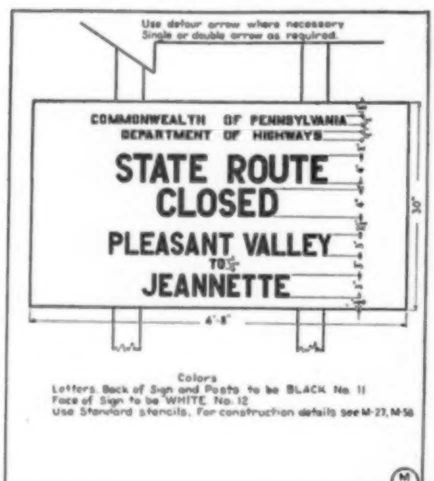


Fig. 2—Standard Road Closed Notice

From the above we have determined a fair measure of the cost per mile per day of a detour to the public. For a detour accommodating 2,000 vehicles per day that cost per mile as closely as can be determined, would be expressed as follows:

$$2{,}000 \times 14 \text{ ct.} + \$1.20 = \$281.20$$

Half-Width Construction. — The Pennsylvania Department of Highways has made a careful study of the problem of traffic accommodation as brought about by construction work whether it applies to the detour or to the accommodation of traffic over construction work. Where traffic is economically led over the contract half-width construction, high-early-strength concrete has been considerably used. As a rule, the plan consists in paving the first half-width section using a high-early-strength cement capable of yielding a concrete sufficiently strong to accommodate all traffic 24 hours after being laid. One-way traffic lanes are thereby reduced in length to from 1,200 to 1,500 ft., all of which involves very brief traffic delay. When laying the second section of a pavement, high-early-strength concrete is used for sections about 600 ft. long, located at about 1,500 to 2,000 ft. intervals. These short sections of high-early-strength concrete will serve to permit traffic to pass while the intervening portions of the last half-width sections are curing for the normal 10-day or 2-week period, usually required for normal portland cement concrete.

This plan works out with excellent results where the grading is not con-

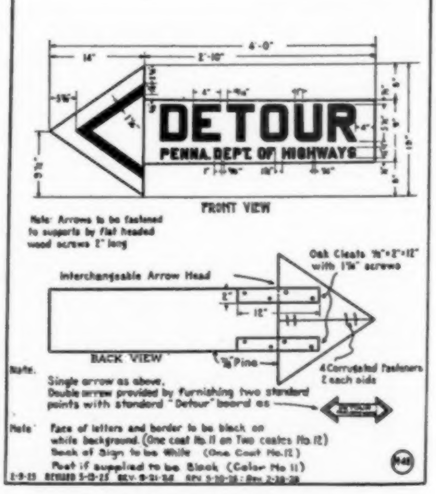


Fig. 4—Standard Detour Arrow

sidered excessive or where the detour would involve considerable inconvenience or additional length to the traveling public.

Reducing the Detour Period. — A detour usually involves additional traveling distance. Whenever the distribution of goods involves highway transportation, the consumer pays the distribution costs whatever they may be. In New York City, out of every 100 hours a truck is paid for working, only 36 are engaged in productive work; the balance are consumed by traffic delays of some kind. It has been determined by the Russell Sage Foundation that the loss in New York City alone in traffic delays amounts to $1,000,000 per day. A detour accommodating from 800 to 3,000 vehicles per day involves tremendously increased costs due to delays to traffic.

A striking example of decreased operation and time loss for highway traffic is the Holland Vehicular Tunnel. It permits an average saving of at least 35 minutes per vehicle crossing the Hudson River. At present about 30,000 vehicles per day pass through the tunnel. By applying the prevailing operation and time loss rates to the trucks and autos using the tunnel and also including a fair estimate of the value of the time of car occupants, we will find an economic saving in 2½ years, more than sufficient to pay for the entire tunnel requiring eight years to build and costing upwards of $48,000,000.

Every detour involves these same factors. The detours of Pennsylvania in 1928-29 were 819 miles longer than the main state highways for which they were substituted during construction. The daily average traffic for the 819 miles of detour was 825 vehicles as extending over a period of about 120 calendar days. From this the total cost of all state highway detours

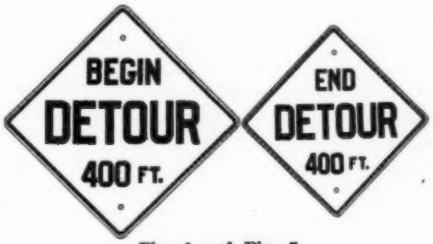


Fig. 6 and Fig. 7

to the users of Pennsylvania State highways above the costs of operation, had there been no detours, is conservatively expressed as follows for the 120-day period:

$120 \times 825 \times 819 \times 14$ ct. = $11,351,340

This sum is sufficient to build over 200 miles of new highways and represents an actual expenditure on the part of highway users for which no returns are forthcoming! Undoubtedly other States are paying proportionately.

During our busy construction seasons, long stretches of newly built concrete pavements lie idle while the pavement laid during the last few days' work at the end of the contract is curing. Meanwhile detour costs are mounting and the public is deprived of the use of the investment. Frequently a detour may be shortened by diverting traffic over an intermediate highway to give it access to a portion of the new pavement. These are cases requiring careful engineering investigation and the application of economic procedure.

The Pennsylvania Department of Highways is, at the present time, carefully studying the feasibility of using rich mixes and a 24-hour concrete for the last nine days' work of laying full width pavement while the contract is closed to traffic. It appears safe to assume that a rich mix with a normal mixing time of 1¼ minutes will yield service strength concrete in about six days. By the use of this method in reducing the curing period, in combination with a cement capable of yielding service strength concrete in 24 hours under normal curing conditions, it becomes possible to reduce the period of duration of the detour at least by nine days. The most economical solution of this phase of the problem of reducing detour costs, therefore, rests in the combined use of a rich mix capable of yielding 6-day service strength concrete and a 24-hour service strength concrete. In both cases the period of mix remains 1¼ minutes, thereby permitting the maximum daily production.

The question arises—when does it become economically wise to use high-early-strength concrete for the last nine days run of full-width construction in order to reduce the detour period by nine days? First, let us determine the additional cost of high-early-strength concrete for an average nine days' paving operation.

Assume the average length of daily full-width paving equals	500 ft.
Assume pavement width equals	18 ft.
Assume additional cost per sq. yd. using a 6-day rich mix (1 — 1.7 — 3) with a 1¼-minute mixing period based on average current prices equals	.14
Assume additional cost per sq. yd. for high-early-strength twenty-four-hour concrete equals	.40

Fig. 5—Route Marking, Detour and Temporary for United States Highways and State Traffic Routes

Then the additional cost for the last 9-day period of laying pavement is expressed as follows:

$$(4 \times 500 \times 2 \times 0.14) + (5 \times 500 \times 2 \times 0.40) = \$2,560$$

Therefore, when the product of saving in duration of the detour in days, the average daily number of vehicles using the detour, and car operation cost per mile plus time loss expressed in car miles (viz. 14 ct.), equals or exceeds \$2,560.00, then high-early-strength concrete should be used and the life of the detour shortened by the 9-day period.

Formula of Justification for Use of High-Early-Strength Concrete

Assumptions:
- Saving in curing time 9 days.
- Vehicle operating cost per mile, \$0.14.
- First constant $14 \times 9 = \$1.26$.
- Second constant additional cost of high-early-strength, \$2,560.
- High-early-strength concrete required on last 4,500 ft.

Formula:
- C_1 = Constant \$1.26.
- C_2 = Constant \$2,560.

Where
- T is average daily traffic,
- L is length, in miles, of detour,
- C is length, in miles, of main highway, then $T(L - C) \times C_1$ is equal to or greater than C_2.

Any combination of pertinent detour and traffic facts can be readily co-related to answer this question when applying the above method of solution. For instance, when a detour is two miles longer than the main highway, economic limit of the detour plan is is reached when the daily average traffic approximates 1,000 cars per day. Again, when the average daily traffic approximates 2,000 cars per day, the economic limit of the detour plan is reached when it is about 1.0 mile longer than the main highway.

Acknowledgment.—The foregoing is a paper presented at the 1930 meeting of the Highway Officials of the North Atlantic States.

The Student's Opportunity in the Highway Industry

Engineering students today who specialize in highway engineering will find many avenues of employment open to them as they go from the halls of learning to the beckoning fields of a life career. Highway engineering means in a general sense all activities that have to do with the highway industry, sixth of the nation's industries from a standpoint of finance and ranking among the leaders in the number of people associated in it.

Last year, 5,651,000 motor vehicles were produced in the United States and Canada, with a valuation of some \$3,483,900,000. These with those already in use, brought a total registration figure for the year of 26,400,000 motor vehicles, an 8 per cent gain in registration over 1928.

Twenty-six million motor cars and trucks that have to have somewhere to go. Of the total 3,016,281 miles of highways in the United States, 660,000 miles are surfaced. The rest range from mountain trails to fairly serviceable secondary roads.

These facts show plenty of work ahead for the road builders. Automobile registration grows by leaps and bounds. Highways must keep the pace. There is no other solution to the increasingly difficult traffic problem.

Abroad, the nations that have been active in road building have likewise reaped the benefits of their efforts, and they, like the United States, are now ready to increase their programs and spend greater sums than ever before for highway systems. With the possible exception of a few of the European nations, such as England, France, Germany and Italy, most foreign countries lag far behind the United States, not only in the amounts they spend for roads but in their methods of construction. They lack also, the modern machinery which American manufacturers produce.

Russia at present is spending vast sums for machinery in this country and American highway engineers are in great demand there to build roads on the American plan. The soviet government has made great appropriations of government money for road construction. China and Africa are also awakening to their need of highways and these great expanses of undeveloped country offer an outlet, bewildering in its scope, for American highway materials and man power.

Gas taxes amounting to \$450,000,000 and motor vehicle taxes in the amount of \$925,000,000 have been applied annually to develop great sums which should be, and in most cases are, immediately made available for extension of the field of motor vehicle use.

Participating factors in the great highway industry are many and varied.

The numbers of manufacturers of highway machinery and equipment have grown into the hundreds, which has developed healthy competition. Each manufacturer is striving to bring new and improved products into the field. Great research departments are at work, year after year, to bring forth speedier equipment which will build more roads, in less time and at greatly lessened cost.

New methods of surfacing and new products for road surfaces are being studied out in laboratories and after careful and comprehensive tests, placed on the market.

Annually, the leading manufacturers hold an exhibition of machinery and materials known as the "Road Show," which is sponsored by the American Road Builders' Association. This organization, made up of members from all branches of the industry, spends its energies in a vast program of research and education, with the annual exposition supplemental to the convention of members to hear the reports of the year's work of its fifty or more research committees. These reports are made from a study of present practices with recommendations for improvement and progress.

The engineering and sales departments of the manufacturing establishments are ever on the alert for suggestions from the contractors, who have the actual building operations in hand, and from the state, city and county officials, under whose supervision the road programs are carried out.

The modern contractor has a much more difficult task to meet with the high-class specifications which are a part of road construction bids. He must needs have an efficient establishment with the best of machinery, highly-trained engineers, and probably of most importance, he must be thoroughly reliable.

The official road building department of the state or city, in most cases, consists of well paid specially trained men, who make engineering their profession, and whose chief aim is thought to be service to the people in discharging the public trust. This holds true in many counties, but there is much chance for development in most counties.

New Automobile Toll Road Across the Austrian Alps Projected

A new automobile road across the Austrian Alps in the vicinity of the Grossglockner has recently been proposed, according to the Automotive Dision of the U. S. Bureau of Foreign and Domestic Commerce. This road will provide an entirely new connection between the province of Salzburg and Carinthia. It will also provide a new and much shorter route from Bavaria and all southern Germany to Italy and the Adriatic. At present there is no automobile route across the Alps between the Brenner, which connects Innsbruck and southern Tyrol, and the so-called Katschberg route, which leads from Radstadt in Salzburg via Mauterndorf and Gmuend to Carinthia. The proposed road will be between these two existing routes.

The project has now advanced to the joint where the province of Salzburg has passed a resolution to bear its share of the cost of this undertaking, provided the provinces of Tyrol and Carinthia also agree to bear their share.

The proposed route will be about 27 miles long and will connect Ferleiten in the north with Heiligenblut in the south. The highest point of the road will be about 8,250 ft. above the sea. At this point there will be a tunnel, about 840 ft. long. The cost of the whole project is estimated at about \$1,140,000 to \$1,710,000. It is estimated that by charging about \$3.50 per car for the use of the road that interest charges and amortization can be met, as from 100,000 to 120,000 persons are expected to use this road per year.

Finishing Machines on Bituminous Pavements

Methods of Machine Finishing for Bituminous Pavements on Highways and City Streets

By C. L. DONOVAN
The Lakewood Engineering Co.

THE tremendous increase in the use of finishing machines for finishing bituminous surfaces, on both state highways and city work, has largely been due to the recognized saving in labor and time, and to the admitted better quality of the finished work. Not only has machine finish made asphaltic roadways more accurate as to riding surface and crown, but it has also provided a more even distribution of material, thus increasing the quality of the pavement.

Finishing machines, at this writing, have been used successfully on practically all of the so-called "hot mixes" and of late have been used with marked success on such cold mixes as Kyrock. It appears that any mix that is suitable for hand raking can easily and successfully be finished by machine.

At the present time, machines are operating where various sizes of plants are in use. Some of the larger plants have a capacity of 900 to 1,000 tons per day. The greater number of machines have been used on plants having a capacity of 250 to 450 tons per day.

Production Increased by Finishing Machine.—We have found in a great many cases with low production on the average size plant the main drawback has been the inability of the road crew to handle the material turned out by the plant. With the application of the finishing machine, the production in several cases has been doubled on account of the ability of the finisher to handle the maximum capacity of the plant, plus a saving in the number of skilled laborers used.

As an example of the installation of a finisher after a job was in progress, the average production for 19 days of hand raking was 1,400 sq. yd. per day, against an average production to the completion of the job of 14 days of 2,300 sq. yd. with the use of the finisher. Also, eliminated the use of four rakers. The plant in this case has a pug-mill capacity of 800 lb.

It is possible to lay about 700 sq. yd. per hour on an 18 ft. road and with an increase in width of pavement, production will increase accordingly as the machine has a constant forward speed, or working speed, regardless of width.

Machine Finish Saves Labor.—The saving in labor where machine finish is used is obvious. Only one back raker is necessary, although where spreader boxes are not used (as in the case of small plants) the usual number of shovelers must be retained. The use of spreader boxes will eliminate all but one shoveler, although two men must be used to operate the boxes.

As an example of the saving due to decrease of labor with the finisher, the following is the crew used on a job before and after a finisher was installed.

Crew Used on Binder Course (Re-Surfacing Old Macadam Road)

Hand Raking	Machine Finish
1 foreman	1 foreman
10 shovelers	4 shovelers*
1 tamper	1 tamper
1 truck dumper	1 truck dumper
4 rakers	1 back raker
2 roller men	2 roller men
19	10

Crew Used on Top Course (Sheet)

Hand Raking	Machine Finish
1 foreman	1 foreman
10 shovelers	4 shovelers*
4 rakers	1 back raker
2 strike-off templet men	1 steel strip carrier
2 tampers	1 truck dumper
1 truck dumper	1 machine operator
2 roller men	2 roller men
26	11

*In this case the endgates of the trucks were tied and the material partly spread by the trucks.

The contractor operating a small plant is at an obvious disadvantage in that he has less chance of realizing the full advantages of machine finish, because of the fact that his crew is practically identical to the crew used by the contractor operating a much larger asphalt plant. But in either case, the finished surface has been greatly improved no matter what the capacity is.

Thus, on the larger capacity plant with spreader boxes in use, the contractor not only enjoys a distinct saving in labor, but also achieves a saving in the unit costs of labor, due to the greatly increased production of pavement possible to lay.

Where a small plant is in use, it is a distinct advantage to haul the material in small trucks so that the interval beween loads will be shorter and the screed member kept at a more uniform warmth. This is especially true on sheet asphalt where the initial compaction under the screed member is about a quarter of an inch, resulting in a surface sealing.

Plants of 350 or more tons capacity daily indicate the use of much larger trucks and, in this case, spreader boxes can be used to decided advantage where machine finish is used. When plants of small capacity are used, the end-gate of the truck can be tied and the material partially spread as the truck dumps. The spreader boxes eliminate the use of a dumping board and shovelers necessary to cut the material ahead of the finisher.

Forms. — The machine must, of course, be run upon forms of strength and contour sufficient to support it. Where a concrete base is already in place, the machine is operated on the edge of the concrete header.

On the many successful applications of machine finish to asphaltic pavements, many types and sizes of forms have been used. Probably the most popular wood forms have been 2x8, 2x6, or 3x6's stood on edge and fastened to wood stakes. In some cases, where the machine is used to finish both binder and top course, a 4x4 is used for the binder course after which a 2x4 is spiked to the 4x4 to allow for the top course.

Too much emphasis cannot be placed on the careful setting of the forms, because they are the governing factor of the smoothness of the finished pavement. Where the finisher is operated on concrete headers, the headers should be straight-edged to the required smoothness of the finished pavement.

It is recommended that steel strips be placed on wood forms when a finisher is used to guard against possible damage to the form from the sliding action of the screed member as well as to bridge any irregularities in the forms themselves. These steel strips can be of suitable thickness to compensate for the roller knockdown, so that the finished material will be left sufficiently high that when rolled it will be of exact thickness. Practically all asphalt finishing machines are provided, however, with adjustable end-shoes which have considerable vertical adjustment to allow for this compression. This feature also permits easy use of the machine on work below the form tops, such as base courses and leveling course work, as through adjustment of these end-shoes the screed member can be operated below the form tops while the end-shoes themselves ride upon the top of the form.

Resurfacing Work.—The resurfacing work consists mostly of surfacing old macadam, gravel, and concrete roads. The first course is generally known as the binder or leveling course which varies in thickness from one to three inches depending upon the condition of the surface being covered.

By lowering the screed member inside of the forms, the leveling course is finished to a true crown and surface.

This makes it possible to spread the top course to the same true crown and surface with uniform thickness of material throughout.

City Streets.—On city street work the finisher can be operated on the inside edge of the integral curb and gutter; on the limestone, granite or concrete curb depending upon the design in use. In the case of the black base, the finisher can be operated on wood or steel forms if no permanent curb is used.

Where there is not a distinct change in crown at the intersection, the finisher lays the center strip and the wings are hand raked. If there is a distinct change in crown, the whole of the intersection is hand raked, either before or after, and the finisher is used only on the straightaway.

Where manholes and monuments are in place, no difficulty is encountered in finishing over them when the top course is laid, if they are properly set when the base is poured. On the binder course, the screed is raised over the objects and the back raker can easily rake the width of the manhole or monument.

On streets wider than 30 ft. the asphalt can be laid in two or more strips, depending upon the width. In such a case, it is best to insert small steel dowels, about 4 in. long, spaced regularly longitudinally down the concrete slab. A wood form is placed over the dowels and the finisher run on this form. As an example, a 60-ft. street can be finished in two 30-ft. or three 20-ft. strips. In the case of a street being finished in two 30-ft. strips, one row of steel pins protruding about 1 in. above base should be placed longitudinally along the street. If three 20-ft. strips are used, two rows will be necessary. These dowels should be placed about every 10 ft. One side of the finisher will ride upon the wood form and the other on the completed pavement protected with a steel angle such as used on curb work.

It has been found that sheet tops of less than 1 in. in thicknes do not lend themselves to machine finish, because of their tendency to tear under the action of the screed member. This tearing is caused by the sliding of the material along the base course under the screed member.

As a conclusive example of the saving effected through the use of the finisher, one state highway department has observed that a difference of 30 ct. per square yard in their contract price on sand asphalt roads has resulted since the use of machine finishing became general in their locality. Another state reports that the price of asphaltic concrete of 1½ in. thickness on new concrete base has been similarly reduced 17 ct. per sq. yd.

Acknowledgment.—The foregoing is a paper presented at a meeting of the Engineers Club of Philadelphia.

Cost of Feeding Street Department Horses at Toronto

The care of horses of the Department of Street Cleaning of the city of Toronto, Ont., is under the direction of a veterinary surgeon, who advises as to the proper feeding of the animals and the necessary precaution against disease. He examines and certifies as to the soundness of all new purchases, and condemns animals unfit for service. During 1929, 46 horses were purchased, at an average price of $226. The following figures on the cost of horse fodder are taken from the 1929 report of George W. Dies, Street Commissioner:

Fodder Consumption, 1929

	Average Amount per Horse per Day	Average Cost per Unit	Cost per Horse per Day
Oats	13.7	$ 0.607 bu.	$0.250
Hay	33.6	15.39 ton	0.259
Straw	4.2	10.84 ton	0.023
Bran	.25	33.81 ton	....
Salt	.05	21.00 ton	0.005
Total	51.8		$0.537
Daily average number horses			383.2
Total horse days			140,283.9
Cost per horse per day			$0.537

The average daily rations per horse, based upon the consumption during the year, amounted to 13.7 lb. of oats, 33.6 lb. of hay, while in addition, 0.3 lb. of other feed, consisting of bran, salt, vegetables, etc., were consumed. Each horse was bedded with 4.2 lb. of straw. While the rational allotment of feed per horse is 15 lb. of oats and 25 lb. of hay, this varies according to the temperament of the horse, as well as to the season of the year. During the heavy drawing period throughout the winter months, it is increased accordingly. On Sundays and holidays, or in the event of horses standing in, only light feedings of oats are given.

Lost Time in Concrete Paving Operations

The State Highway Department of Pennsylvania has issued recently an efficiency report on the concrete paving operations in 1929 under its jurisdiction. The report covers the construction of 4,959,926 sq. yd. of concrete pavement laid in that year in the eight divisions of the state, and gives data on the working hours and on the reasons for lost time in the construction operations. Bad weather and wet subgrade were eliminated from the report as causes of lost time, the only time considered being that when it was possible for the contractor to carry on his paving operations. The following is extracted from the report:

	Total All Divisions
Possible number, working hours	65,209
Hours lost	15,395
Actual hours worked	49,814
Per cent time lost	*23.6
Pavement laid per working hour, sq. yd.	*99.57

*Average for state.

The average yardage per working hour in all divisions except one was over 100 sq. yd. per hour. In this district it was 78.49 sq. yd. per working hour. In one division where the lost working hours were only 12 per cent the average yardage laid per working hour was 115. In another division the lost time was 35 per cent of the possible number of working hours. The causes of the lost time may be summarized as follows:

Reasons for Lost Time

	Total for All Divisions, Hours	Average Percentage Lost of Total Working Time	Average Percentage of Total Lost Time
Transportation	1,700	2.61	11.05
Water conditions	666	1.02	4.32
Subgrade and forms	3,652	5.60	23.72
Breakdowns	2,302	3.53	14.95
Lack of materials	2,608	4.00	16.94
All other causes	4,666	6.85	29.02

Passenger Tramways Make Wonder Spots Easily Accessible

A recent announcement, made by the American Steel & Wire Co., Chicago, Ill., a subsidiary of the United States Steel Corporation, indicates that America will soon have at hand a means of travel hitherto largely confined to Europe.

The appointment of the above company, as sole licensees of the Bleichert and Bleichert-Zuegg Systems, in America, makes available in this country a really successful and efficient system of aerial tramways, for passenger transportation.

It becomes a simple matter, via the aerial route, to climb the highest mountain, or cross the deepest river. Although perfectly safe, this modern means of travel carries with it the thrill of passing through space at high speeds. It permits of unrestricted vision and brings into view every detail of the surrounding countryside. In comfort and ease, in any kind of weather, passengers are transported over vast distances—covering in a few minutes' time territory that would otherwise take hours or days to encompass. Reasonable fares made the systems popular.

Highway Financing.—In a paper presented at the 1930 Highway Conference at the University of Colorado, Prof. L. R. Downing stated that according to a recent survey, the sources of revenue for highways in 1929 was as follows:

	Per Cent
Motor vehicle tax	30½
Gasoline tax	27½
Borrowed funds	14½
Property tax	16½
Federal aid	9½
Miscellaneous	1½

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Will Highways Become a Six-Billion Dollar Industry in Ten Years?

In the United States there is an average of one motor-car for 4.5 people. California leads the states with one car for 2.3 people, Nevada being a close second with one for 2.4 people. Iowa and Kansas tie for third place with one for 3.1 people. When this country as a whole shall have reached the present California standard of car ownership, the number of cars will have nearly doubled. Our roads and streets will then have to accommodate about 53,000,000 cars instead of 26,500,000.

The number of cars increased 8 per cent last year, whereas population increased only 1.5 per cent. If an 8 per cent increase occurs, without compounding, for 12.5 years, the number of cars will be doubled. If the 8 per cent compounds annually, the number of cars will be doubled in 9 years. It is probably not far amiss to estimate that by 1940 there will be twice as many cars in use in America as at present. In any event, the increase is certain to be enormous, and so rapid as to present to highway engineers problems of great moment.

Already the main thoroughfares in many cities are at times congested beyond the limits either of comfort or of safety. City engineers in such places are confronted not merely with technical problems involved in reducing the congestion, both present and prospective, but with political problems. One thing is certain, and that is that the antiquated method of assessing abutting property for street improvement must be abandoned if the existing congestion is not to grow much worse; for property owners rebel, and rightly rebel, at having the entire burden of main thoroughfare improvement thrust upon them. Another thing seems equally certain, and that is that laws must be so modified as to secure a considerable part of street improvement funds from gasoline taxes and motor-car licenses. Such changes in laws involve politics, but engineers should not hesitate to advocate political measures that will assist them in relieving the growing congestion and the growing danger of automobiling.

Turning to another aspect of the increase in motor-cars, we see that there is in sight a more rapid growth of highway construction than of any other large branch of the construction industry. America is now spending about three billion dollars annually in road and street construction, improvement and maintenance, including snow removal and street cleaning. If the number of motor-cars shall double in 10 years, the money collected from gasoline taxes and licenses will more than double, for many states will undoubtedly raise the tax rates. Bond issues are likely to increase in per capita volume, for motorists will continue to be impatient to lengthen, widen and otherwise improve the highways. And why not? As we have repeatedly shown, highway expenditures continue to lag far behind the increase in motor-car expenditures. The American public has chosen to spend on motor-cars a very large part of its annual increase in earnings. Shall it be denied the right to call for commensurate annual expenditures on the tracks over which those cars must run?

Recently a prominent banker in one of our largest cities issued a broadcast warning against "our mounting taxes," and he spoke particularly of the taxes for road and street improvement. Why didn't he issue the same warning against buying more goods of any kind? He is evidently one of the old school of economists who believe that income is a limited commodity, and that much of it should be hoarded—put away in savings banks. He fails to see the true significance of the fact that the average real income of the average American has quintupled in the last century, and is increasing fully as rapidly as ever. We say "real income" meaning the quantity of good that "money income" will buy.

What shall be done with this annual increase in income? Hoard it? That would not only be absurd, but would bring a halt to progress, for it would result in overproduction, by creating unsalable products. Why go on improving methods, machines and production devices generally, if the result is to be failure to use the increased output? The banker who urges curtailment of taxes for public works is really telling people that they are fools to expend their incomes for desired goods and services; for there is not an iota of difference between expending money for highways and expending it for the vehicles that use the highways, except that in the one case public officials do the buying for the tax payer and in the other case the tax payer does his own buying.

The human stomach is limited in capacity and therefore there is a rigid limit set by nature upon expenditures for food needed to sustain life and to give adequate pleasure during the eating of it. The human body needs but one suit of clothes at a time, and while a person may enjoy having two suits or a hundred suits, he needs but one, and any expenditure beyond that need usually becomes a luxury. In America fully four-fifths of our expenditures are essentially for luxuries, if by that term we mean all beyond the necessities that our

forebears had a century ago. They lived and therefore they had all the necessities of life. We who have five times their real income must therefore spend about $1 for bare necessities and $4 for luxuries. This holds true of the average artisan and even of the average day laborer in America.

So let us have a surcease of advice from bankers or other well meaning hoarders as to how we ought to spend our increased incomes, or rather, as to why we ought not to spend them at all. They belong to a school of political economists that brought the science of economics into such disrepute nearly a century ago that it is still often spoken of as "the dismal science."

Malthus pictured a human struggle for existence that would ultimately reduce all to penury. Of birth control he had not a thought. Of scientific discoveries that would steadily increase average incomes, and lift the common workman in an American factory to an income level above that of a successful English barrister of the Malthusian era, Malthus had not even an evanescent dream. Our banker friend who bids us beware the tax dog, is a real Malthusian, a creature almost extinct in America, but surviving here and there in some business cranny, and uttering weird cries of distress at the appalling extravagance of the American people.

The Reasons for the Popularity of Motoring

When motor cars first began to attract much attention, 35 years ago, it was often predicted that the "fad" of motoring would run its course in a few years, and die a natural death. That prediction was largely based on the history of bicycling, but the prophets failed to take into account several important differences between motoring and "wheeling." The most important of these differences springs from the aversion that the average person has for prolonged, hard, muscular work. To "wheel a century" on a fine June day sounds very alluring and is alluring—just once. When you roll back to your little home at night after pedaling a hundred miles, you inwardly resolve to brag a lot about your wonderful trip, but never to repeat that trip. Sticky with sweat, grimy with dust, and creaking in every joint, you are simply through with century rides, and doubly so if you were the man on "the bicycle built for two."

Few men and fewer women could stand those long jaunts, so they ceased to make them. As for the short rides, they became monotonous from lack of variety. So the fall of the roaming empire of the bike was even more rapid than its rise. You have to go to Europe or Asia now if you want to see many grown-ups riding bicycles, and the numbers are not strikingly great. What you see there is the bike as a device for conveyance to and from work, rather than as a pleasure vehicle.

Say what you may about the economic utility of the automobile—and all that you say will fall short of the truth—its great attractiveness has always been and still is its pleasure giving quality. Do you seek to escape the humdrum of your neighborhood for a day? The automobile is your "magic carpet" on which you may float to interesting realms. Do you crave a bit of sport with pole and reel? Your motor-car will take you in three hours from the crowded streets of Los Angeles to the high Sierras where fish are fish and men are men. Does your golf ball halloo to you from a distant locker near the green? Before the echo of its call has died away, your car has brought you to the club. Instances like these serve to show that the automobile is not only pleasure giving in itself, but that it serves as a means by which you are enabled to secure other pleasures. To the typical American his motor-car is a gift from Aladdin, "the lamp and the ring" whose magic power makes natural beauties and all outdoor sports act as slaves to its possessor.

Prospective Gasoline Taxes and Their Effect on Road Work

The American Petroleum Institute states that gasoline taxes in 1929 amounted to $499,781,000. They estimate a 10 per cent increase for 1930, bringing the total gasoline tax up to $550,000,000. Assuming a normal increase of 1,000,000 vehicles, this tax will average $20 per car as compared with $17 in 1929 and $12.50 in 1928. In 1929 gasoline taxes exceeded registration fees for the first time since taxes began to be levied on gasoline. It is estimated that for the five years ending Dec. 31, 1930, motorists will have paid $1,744,400,000 in gasoline taxes, or more than six times the $279,400,000,000 paid during the preceding five years.

In 1921 only 13 states taxed gasoline, most of them at the rate of 1 ct. a gallon. Today all the states tax gasoline, the average rate having been 3.5 ct. in 1929. The 1930 rate will average about 3.77 ct. a gallon, the range being from 2 to 6 ct.

There are nine states that collect 5 ct. a gallon, from which it may be inferred that a few years hence the average rate for all the states is likely to be 5 ct. Along with the steadily increasing average tax rate, there has been not only an increase in the number of motor vehicles but in the annual mileage traveled per vehicle. It may be safely assumed that all three of these factors will continue to increase for several years. Therefore it follows that expenditures for highway improvement and maintenance are quite certain to rise in geometric ratio.

We need not be surprised to see the number of motor vehicles in America double within the next 10 years. If so, the annual expenditures on roads and streets will more than double. In 1930 those expenditures, inclusive of maintenance and street cleaning, will probably be not much less than three billions of dollars. This is a huge sum, but it is less than 3 per cent of the annual income of the American people.

H. P. Gillette

A New Elevating Grader

A new elevating grader with a number of new features has been announced by J. D. Adams Co., Indianapolis, Ind., manufacturers of Adams leaning wheel graders and other road building and maintenance equipment.

The new features include the use of anti-friction bearings throughout—Timken roller bearings in wheels and Timken and ball bearings throughout carrier and carrier drive—a new shaft and gear driven carrier, a new carrier construction which provides unusual rigidity with light weight, a new automatic pan cleaner, belt tightener, etc.

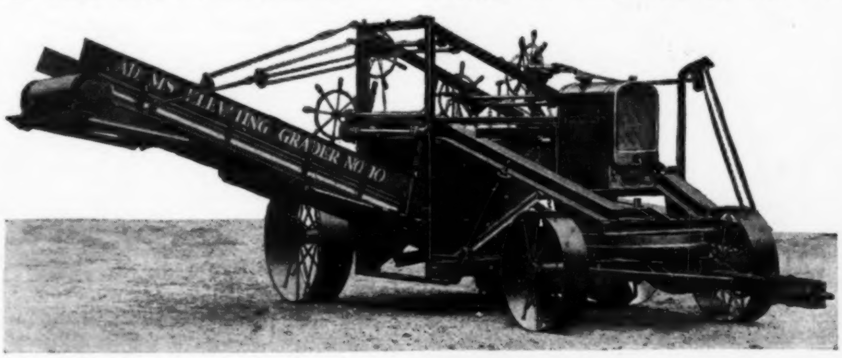
Probably the most outstanding feature of the new Adams elevating grader is the new type carrier which is driven by shaft and enclosed gears instead of by the usual chain. The carrier is driven either by power take-off from the tractor or by an auxiliary motor mounted in the forward section of the machine as illustrated. The rear axle drive has been entirely eliminated. The carrier drive shaft runs back from the motor shown in the illustration, angles through a set of bevel gears, and drives another set of bevel gears at the drum by means of a square steel shaft telescoping in a heavy square steel tube. The drive shaft is mounted on ball bearings and all bearings and gears are tightly enclosed to protect them from dirt and dust.

The upper drum and lower roller of the carrier are mounted on ball bearings and all carrier rollers are mounted on Timken bearings. The carrier rollers are tubular steel and the Timken bearings are carefully encased inside the rollers fully protected from dirt.

J. D. Adams Co. claims to be the first elevating grader manufacturer to use anti-friction bearings at every point of power consumption—even the automatic pan cleaner, which uses roller chain driven by enclosed spiral gears, is ball bearing equipped. This results in an extremely light running machine which requires the absolute minimum of power for operation and leaves the maximum of power for moving dirt. It is claimed that the carrier is also extremely easy on belts because of its rigidity and perfectly aligned ball bearings which keep the belt running true. The belt is also given much more than the usual protection, being guarded by steel plates, grids, guard rollers, etc.

The machine is furnished with power take-off or auxiliary motor, either of which drives the carrier with much less power than required by the old rear axle drive, and makes the carrier operation independent of tractive conditions. The machine uses a 42-in. belt and is regularly equipped with 28-in. disc plow.

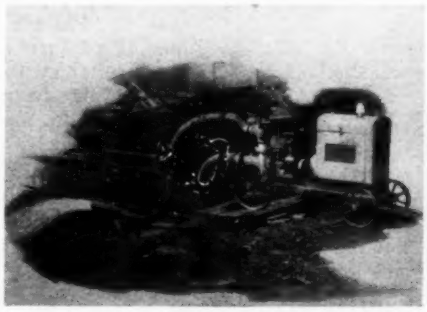
Any one interested in elevating graders or dirt moving will be interested in a profusely illustrated special catalog issued on this new machine. Just address J. D. Adams Co., Indianapolis, Ind.



Adams New Elevating Grader

New Self Priming Centrifugal Pump

Much interesting development and research work has centered around a new self-priming centrifugal pump that



Self-Priming Centrifugal Pump

the Chain Belt Co., Milwaukee, Wis., has recently put on the market. C. I. Longenecker, engineer for the company, who has spent the greater part of his life designing pumps, developed this new pump which, it is said, takes practically all the air out of the chambers and maintains its prime.

The new pump is in addition to the line of pumps the company now manufactures and is a part of the line of construction equipment consisting of concrete mixers, pavers, saw rigs central mixing plants, etc.

It is claimed that the new self-priming centrifugal requires no attention even though the water does go below the end of the hose; the vacuum is maintained automatically and the pump needs no priming. Just as soon as the water begins to drop the vacuum pump begins to exhaust the air and pick up the prime again. In the new pump Mr. Longenecker has made it possible to remove air pockets before they can be sealed and not interfere with the pump's prime, also its lifting capacity.

Pedestal Grinder

Ingersoll-Rand Co., 11 Broadway, New York City, announces a bench-type pedestal grinder, known as the Type 9, which can be bolted to a bench or a portable air compressor.

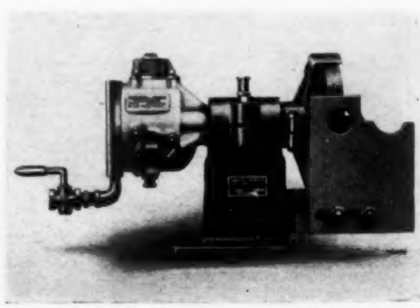
The flow of air to the motor is controlled by a hand-operated globe valve. The machine has a free speed of 3,000 r.p.m. and is designed to take a vitrified grinding wheel 6 in. to 8 in. in diameter with a ½-in. face. At the end of the grinder spindle, a bit chuck is screwed to take a drill or reamer with ½-in. straight shank.

The motor, which is of rugged design, has three cylinders, spaced about the center line of the spindle. All deliver power to one crank pin. The three cylinders are interchangeable. The motor operates in a bath of lubricant, so that all moving parts are continuously immersed.

The exhaust is directed through the base of the machine—a feature which prevents the grindings from being blown into the face of the operator. A steady-rest in front of the wheel aids the operator in holding the work.

On contract work, a grinder of this type can be used for grinding or sharpening chisels and picks, squaring up drill steel shanks, and taking care of the miscellaneous grinding jobs that are usually encountered. Considerable time can often be saved by having a grinder right on the job to do these tasks as need arises.

Many public utility companies find extensive use for such a grinder in connection with their truck-mounted portable compressor outfits. A grinder mounted on the truck enables the operator to take care of many odd grinding jobs when the compressor unit is at work on repair jobs or service installations.



Special Size 8 Pedestal Grinder

Batcher for Wheelbarrow Batching of Aggregates

A small batcher for wheelbarrow batching of accurately weighed aggregates, for building culvert, small bridge and curb and gutter work where the job does not justify the setting up of a complete bin and batching unit, has been brought out by C. S. Johnson Co., Champaign, Ill.

Weighing but 280 lb. it can be loaded and unloaded easily from trucks—and with the two large diameter wheels can be moved around on the job by one man. The shoveling height is 42 in., a height tested to prevent easy tiring. The capacity is 4 cu. ft. or 400 lb., a full wheelbarrow load.

The discharge is a simple sliding gate with nothing to get out of order—high enough for any standard wheelbarrow. The hopper is round, free from any obstructions that might allow the materials to build up—and only the material directly in it affects the weight.

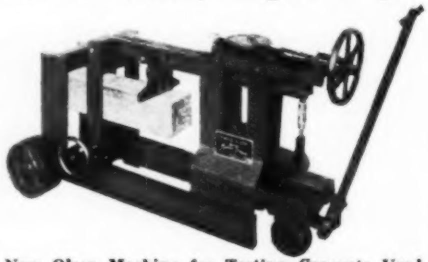
The feature of this batcher is the weighing unit—the Johnson weigh. Scale parts are entirely of bronze, eliminating rust and standing up under long service. The beam balance indicator, warning the operator of approaching balance, balance, and overload, can be read from either side—all that is necessary is to set the beam for the desired weight—run the wheelbarrow under the discharge, and shovel into the hopper until the beam balance indicator shows a balance. It is an extremely simple unit—without springs—eliminating the usual necessary wait for the beam to balance.

This batcher is a unit entirely separate from the mixer and is consequently not affected by mixer vibration, it permits the mixer to move along with the job, without the necessity of constant moving of the stockpile.

The Johnson Bantam Weigh Batcher

Concrete Beam Testing Machine

A concrete beam testing machine for determining the modulus of rupture of concrete, designed to permit the testing of three sizes of beams in the one machine, has been placed on the market by the Tinius Olsen Testing Machine Co., 504 N. 12th St., Philadelphia, Pa. The modulus of rupture is indicated direct by dial reading without computation when testing beam sizes 6 in. by 6 in., 6 in. by 8 in. and 8 in. by 8 in..



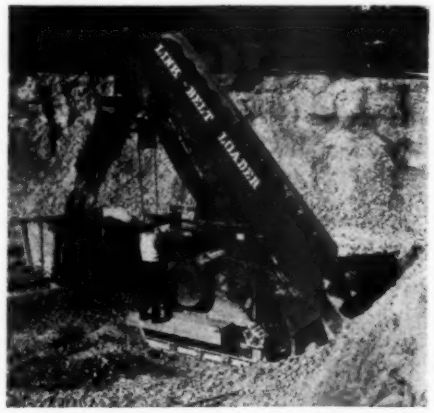
New Olsen Machine for Testing Concrete Used in Pavement

The beam is placed in this machine and load applied at either 10 in. or 12 in. from the point of support as desired. The beam is inserted in the machine and adjusted for alignment or for removal of specimen by operating the handwheel shown at the left. The load is then applied by operating the horizontal handwheel until rupture occurs, when the maximum load is indicated by a set pointer on the dial. The maximum load that can be indicated or the capacity of the machine is 1,000 lb. Stops are provided to protect the instrument at the rupture point of the specimen and every possible point covered whereby this equipment will give the very best of service under the hard conditions under which it will be used in the field. To facilitate the use of this machine, it is also mounted on wheels, which makes it very convenient to move from place to place.

Link-Belt Announces New Crawler Loader

The Link-Belt Co., Philadelphia, Pa., announces the development of a new high-capacity crawler bucket loader, known as the Grizzly, 1930 model; and that, after having given the machine a thorough tryout under actual working conditions, they are going into production on a large scale.

Particular stress is laid on the construction of the self-feeder with which the loader is equipped. This new feeder is of the continuous helical ribbon type, which feeds and cleans up uniformly. The action of its self-sharpening spiral and correct cutting edge serves to cut, dig and convey the material to the elevator buckets in a smooth, continuous, uniform stream. There are no blows or shocks. The adjustment of the feeder is controlled by a handwheel within easy reach of the operator, who rides with the machine on a conveniently-placed side platform.



New Link-Belt Crawler Loader

The machine has a rated capacity of 1¾ cu. yd. per minute, based on handling sand, stone and gravel, 1½ in. and smaller, run-of-mine coal, coke, etc. Larger stone may be handled at a somewhat smaller capacity.

The power unit is a 30-hp. Buda gasoline engine, or a 20-hp. electric motor, for operating the bucket, the elevator, the feeder and the crawler traveling mechanism.

The crawler frames are one-piece steel castings. The crawler is wide and long to give the machine ample stability for the work to which such machines are customarily subjected. It is also said to be self-cleaning.

DISTRIBUTOR NEWS

The Distributor's Department in the Gillette Construction Group

"Down Among the Sugar Cane"

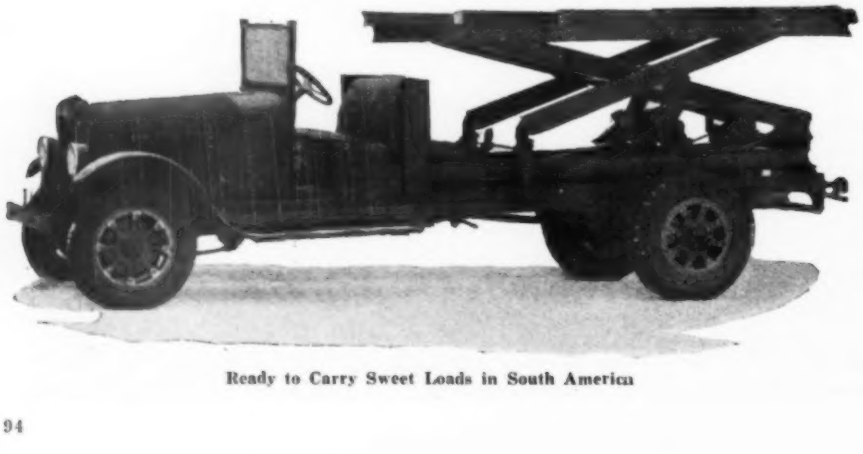
Down in Cartagena, South America, under the hot tropical sun, the harvesting of the sugar cane might be done in a wasteful and tedious manner, but the system told about here sounds easy, swift and painless.

The illustration shown is a Reo truck equipped with Wood Hi-Lift hoist and steel subframe, and is one of a large fleet which has gone from Michigan, where trucks and hoists grow, down to Cartagena, where sugar cane grows to handle this crop, it is said, single-handed.

Mr. F. L. Waite, President, Waite Engineering Equipment Co., Lansing, Mich.

As fast as the cane is cut it is chuted into large bins. Four high posts support each bin. As soon as a bin is filled, a truck runs between the posts and raises the subframes until the bin is lifted clear. The truck then does its part, whisking the load away to its destination where the hoist lowers it again to another set of posts. Thus, without wasting time for loading and unloading and with practically no extra equipment, it is said, hundreds of tons of cane can be handled daily.

Installation of the hoist mechanism was made by the Waite Engineering Equipment Co., Wood distributors, at Lansing, Mich. Mr. F. L. Waite is the head of this organization.



Ready to Carry Sweet Loads in South America

W. H. Moore Joins Autocar Company

Mr. W. H. Moore, whose first contact with the automotive industry was in 1908, when he joined the White organization in Pittsburgh as assistant manager, has joined the Autocar Company of Ardmore, Pa. Mr. P. H. Coale, vice-president in charge of sales for Autocar, in making the announcement stated that Mr. Moore had been appointed manager of the National Accounts Division of the company, with headquarters at the Autocar branch in New York City.

For many years Mr. Moore was a prominent member of the White sales organization, serving as manager of the Pittsburgh branch of this company for almost ten years and then taking charge of the New York district. He was appointed assistant vice-president of the company in 1923, but in 1926 resigned to join the General Motors Truck Co., for whom he opened branches at Boston, Worcester, Springfield, Hartford and Providence.

Roots Merges

The P. H. & F. M. Roots Co., original patentees and for seventy years manufacturers of Rotary Positive Blowers, pumps and meters, has merged with other interests and is now under the control of the Stacey Engineering Co. of Columbus, O.

The new organization includes the P. H. & F. M. Roots Co. and the Connersville Blower Co., both of Connersville, Ind., the Wilbraham-Green Blower Co. of Pottstown, Pa., and the Stacey Brothers Gas Construction Co. of Cincinnati, O.

Heading the list of officers Colonel Carmi A. Thompson, of Cleveland, was elected president; Corwin Abbott, vice-president and general manager; Fletcher S. Heath, of Columbus, O., vice-president, and Erle G. Meeks; secretary and treasurer. Charles T. Gordon will continue as general superintendent.

Mr. E. D. Johnston, who for the past forty-five years has been connected with the P. H. & F. M. Roots Co., has resigned as president of the company and has retired from active business.

The new board of directors consists of Colonel Thompson, F. S. Heath and C. A. Ward, of Columbus, O.; W. B. Stacey, of Cincinnati; J. T. Wilkin, Corwin Abbott and Charles T. Gordon, of Connersville.

All companies involved in the merger will maintain their separate identities and organizations, and will continue to operate separately until the final plans of the merger can be consummated.

W. J. Savage Joins Brown Clutch Co.

Mr. O. F. Rinderle, president of The Brown Clutch Co., Sandusky, O., manufacturers of Brown "Giant-Line" hoists, recently announced the appointment of Mr. W. J. Savage as manager of sales.

Mr. Savage has been associated with the Heltzel Steel Form & Iron Co., Warren, O., for the past thirteen years as sales and advertising manager.

Another Record Year

In a statement recently issued by Mr. Roger Birdsell, vice-president of the Perfex Corporation of Milwaukee, he says: "Our business is with manufacturers of mobile industrial equipment and automobile trucks. If our business in the first quarter plus that which we have scheduled for April is a barometer of what other business men think then 1930 is going to be a good year."

Mr. Birdsell stated that while 1929 was the greatest business year in the history of their twenty-year-old organization, every month in 1930 has so far exceeded the same corresponding month in 1929. He estimated the average for the first four months at 34 per cent more than for same period in 1929.

Centralize Offices for Better Service

New York offices of the Universal Atlas Cement Co. are now located at 42nd St. and Lexington Ave. in the New Chrysler Building. This company is a subsidiary of the United States Steel Corporation, and it, together with several other subsidiary companies, supplied much of the material used in constructing the Chrysler Building, according to Mr. B. F. Affleck, president of Universal Atlas.

Materials supplied by subsidiary companies included: Universal Atlas Cement Co., Atlas white and gray cements; Carnegie Steel Co., beam sections; American Bridge Co., structural steel fabrication; American Steel & Wire Co., reinforcing fabric in the concrete floors; National Tube Co., copper-steel pipe used in the drainage system, and the American Sheet & Tin Plate Co., Keystone copper-steel sheets used in the ventilation and air conditioning systems.

The Universal Atlas Co. has 14 mills, said to be capable of producing about one-tenth of the world's supply of cement. It maintains offices in 17 cities, and it is believed that by centralizing the work formerly carried on by Atlas at 25 Broadway and 41 E. 42nd St., and by Universal at 30 Church St., that it will be able to give greatly improved service in the construction field.

About "Jesse" James

In this case "Jesse" James' real name is Mr. Francis H. James, and the sobriquet is bestowed on him as an expression of good-will by his many friends on the Pacific Coast. Mr. James has recently joined Transit Mixers, Inc., manufacturers of Paris Transit Mixers, with the title of chief engineer.

For a number of years Mr. James was connected with the Northwest Engineering Co. as sales engineer for the State of California, and has had a broad experience in the construction field. His acquaintanceship extends over the entire Pacific Coast territory. He will make his headquarters at the home office of the Transit Mixers in San Francisco.

R. W. Gillispie Made President Jeffrey Mfg. Co.

Mr. R. W. Gillispie, President of The Jeffrey Manufacturing Co.

Mr. Robert W. Gillispie, formerly vice-president and general manager of The Jeffrey Manufacturing Co. of Columbus, O., was elected president of this organization at the annual meeting of the board of directors held recently. At the same meeting Mr. Robert H. Jeffrey, former president of the company, was made chairman of the board, a position which has been unfilled for two years.

Two subsidiaries of this company, known as The Jeffrey Manufacturing Co., Ltd., at Montreal, and the Galion Iron Works & Mfg. Co., at Galion, O., will also be served by Mr. Robert W. Gillispie as president.

Foote Bros. Gear & Machine Appoint Additional Officers

At a recent directors' meeting of Foote Bros. Gear & Machine Co. the following officers were appointed: C. C. Commons, first vice-president and assistant secretary; F. A. Emmons, vice-president in charge of gear and reducer sales and advertising; H. H. Bates, vice-president in charge of manufacturing; W. H. Heineman, assistant vice-president; W. O. Bates, Jr., assistant vice-president.

To Promote Export and Distributor Sales for Hercules

Mr. Lon R. Smith has been appointed assistant director of sales for the Hercules Motors Corporation of Canton, O., builders of four and six-cylinder heavy duty engines. His new duties, it is stated, will include supervision of export sales and sales promotion among Hercules distributors.

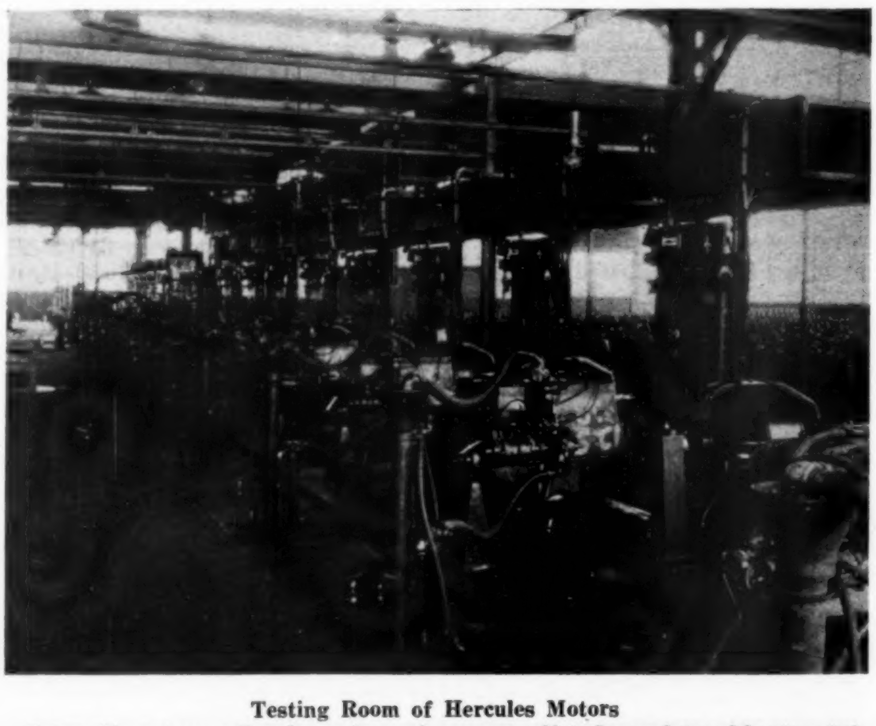
Distributor Notes from Trackson

Among the new distributors who have been appointed recently by the Trackson Co., Milwaukee, Wis., to handle Trackson tractor equipment for the McCormick-Deering tractors is the Gierke-Robinson Co., 4th and Ripley Sts., Davenport, Ia., who will cover the Davenport, Des Moines, Cedar Falls, Fort Dodge, Mason City and Dubuque territory.

Zimmerman-Steeples Equipment Co., 269 E. Water St., Portland, Ore., has been appointed distributor in that territory.

These firms will carry a complete line of Trackson crawlers, shovels, loaders, bulldozers, hoists, etc., as well as a stock of repair and replacement parts.

Problems Connected with the Design of Track-Type Tractors is the title of a paper presented by H. S. Eberhard, of the engineeering department of the Caterpillar Tractor Co. before the Pacific Coast Division S. A. E. recently. Tractor problems of the farmer, contractor, logger and engineer are all touched upon in this paper, which discusses dirt and dust, ice and snow and other conditions to be met and overcome by the tractor.



Testing Room of Hercules Motors

Before shipment every Hercules engine receives a test said to be equal to a laboratory test. Space for additional dynometer equipment shown in picture has been provided in the recently enlarged plant of the Hercules Motors Corporation at Canton, O.

Ohio Steel Foundry Purchases Plant at Bay City

The Ohio Steel Foundry Co., of Lima and Springfield, O., has purchased the steel foundry department and steel casting business of the Industrial Brownhoist Corporation, of Cleveland, O., and Bay City, Mich.

The steel foundry itself is located at Bay City and will be operated at that point by the Ohio Steel Foundry Co., beginning May 1.

Extensive improvements are planned, among the first of which will be a modern 15-ton open hearth furnace.

American Manganese Steel Appoints New England District Representative

Announcement has been made of the appointment of Mr. John H. Coghlan as direct representative in the New England states for the sale of Amsco manganese steel castings.

For many years Mr. Coghlan has been representing the Amsco products through his connection with Harrington, Robinson & Co. of South Boston who, until this time, have been the agents for the manufacturer. In his new position Mr. Coghlan will give his entire time to the Amsco business, and his training as an engineer, together with his years of experience in the manganese steel business, give assurance of adequate attention to the requirements of territory.

In making the announcement of the appointment of Mr. Coghlan, acknowledgment was made by Mr. A. W. Daniels, vice-president of the American Manganese Steel Co., of the capable service rendered by Harrington, Robinson & Co. during the period of years in which they handled the Amsco products.

Mr. Coghlan's headquarters will be at 92 Broadway (Kendall Square), Cambridge, Mass.

Sullivan Machinery Co. announces that it has secured the sales rights for "Tanner-tanks" and "Tannergas" for the prevention of freezing in compressed air lines and at the exhaust of compressed air tools. The device consists of a tank and by-pass piping connected into the air line near the point of use. This tank contains a liquid which forms a gas on combination with the compressed air in the top of the tank. This gas is carried into the air lines, and is the active agent which prevents freezing at the tools.

Announcement

Announcement has been made to the effect that the "Form-Hold" Corporation, Ltd., has acquired all of the assets of the American "Form-Hold" Corporation and is handling the manufacture and distribution of all "Form-Hold" products. It is stated that plans are being made for an intensive sales campaign and improvements are to be made in the "Form-Hold" tie. Manufacture of the diamond head type of Red Head tie has been discontinued and in its place a U head will be manufactured.

This is a California corporation and is located at 410 Security Title Insurance Building, Los Angeles.

Trackson Announces New Appointments

Among the new distributors who have been appointed recently to handle Trackson Tractor Equipment for McCormick-Deering tractors is the Edward R. Bacon Company, San Francisco, Calif., who will cover the San Francisco territory.

The Olympic Machinery Co., Seattle, Wash., has been appointed to handle the Trackson line in the state of Washington.

These new distributors will handle a complete line of Trackson crawlers, shovels, loaders, bulldozers, cranes, hoists, etc., and will be able to give prompt service on orders for these machines and on repair and replacement parts.

Link-Belt Announces New Crane Agents

Link-Belt Company, 300 West Pershing Road, Chicago, Illinois announce the appointment of the following agents who will handle their complete line of Crawler Cranes-Shovels-Draglines, and Locomotive Cranes.

P. L. Tippett, Rhodes Building, Atlanta, Georgia.

Jos. C. Fiorello Co., Larkin Terminal Bldg., Buffalo, New York.

Bacon-Hibbard-Eichman, Inc., 917 Central Avenue, Cleveland, Ohio.

Distributor Appointments

The Heltzel Steel Form & Iron Co. announces the appointment of the following representatives:

Raleigh Tractor & Equipment Co., Raleigh, N. C.; Lombard Iron Works & Supply Co., Augusta, Ga.; Gorman L. Burnett, Inc., P. O. Box 291, Lynchburg, Va.; Dravo Equipment Co., 4800 Prospect Ave., Cleveland, O.; Dravo Equipment Co., 300 Penn Ave., Pittsburgh, Pa.

The Pierce Arrow Motor Car Co. celebrated its twenty-ninth anniversary the first week of May. Distributors throughout the country held special exhibits to commemorate the event. Mr. A. J. Chanter, vice-president and general manager of the company stated that registrations for the first quarter exceeded last year's figures for the same period by more than 115 per cent.

Edward G. Budd Manufacturing Co.'s common stock is now distributed among 4,422 holders. On Feb. 1, 1929, there were 521 common stockholders and 4,177 on Feb. 1, 1930.

House Magazines

Editor's Note: This column is published every now and then. Many most attractive and interesting house magazines come to our desk from time to time, and we take this method of acknowledging them.

Material Handling Illustrated, the very comprehensive and attractive magazine published by the Northwest Engineering Company of Chicago, presents a Spring issue filled with news and views of big material handling projects going on in various parts of the country. Railroad work, mine work, highway work, river excavations, foundation work and many other types of structural projects are graphically told.

The AMSCO Bulletin, which the American Manganese Steel Company of Chicago Heights issues every month, will keep the reader informed about the products of their company and the many uses for Fahralloy and other alloys. A dipper is illustrated and described which is said to be the largest all-manganese steel dipper ever made. The size of the dipper is 15 cu. yd., and working weight is given as 3,300,000 lb.

Power News is published by Fuller & Johnson Manufacturing Company of Madison, Wis., and is exactly what it claims to be, power news. A very interesting article in issue No. 3, volume 1, is called "'Way Back When," and tells the story of the internal combustion engine as produced by this company beginning in 1900. The number also contains a column of service suggestions which will be found of help to the men in charge of servicing equipment.

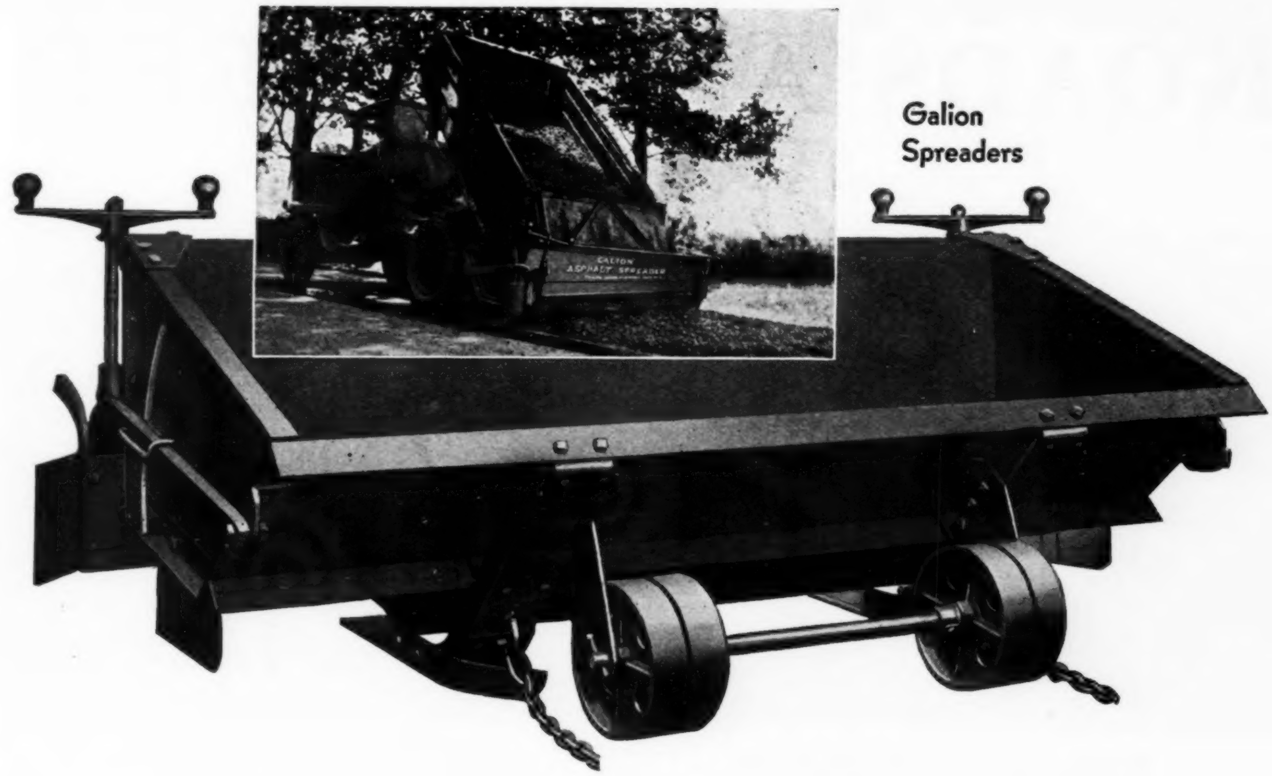
Bores & Strokes, the Schramm, Inc., monthly, "went moderne" in the April issue and carried a beautiful and artistic view of the Bank of Manhattan Tower Building. The issue contained the usual number of pictures showing the application of the Schramm compressor.

Good Roads for March contains a detailed story with many attractive views of executives and headquarters of the new branch office recently opened by the Good Roads Machinery Company of Kennett Square, Pa., at Harrisburg. The new office is located at 36-38 N. Third St., and is in charge of Mr. R. P. McCormick.

A Change in Name

Announcement has been received from the manufacturers of "Conco" products to the effect that this branch of their organization will hereafter be known as Conco Crane & Engineering Works, Division of H. D. Conkey & Co. This company is located at Mendota, Ill.

Pennsylvania Pump & Compressor Co. of Easton, Pa., announces the appointment of Mr. E. H. Bollenbacher, 725 Forsyth Building, Atlanta, Ga., as sales representative in the Atlanta district.



Galion Spreaders

Smooth and Even Spreading

for Asphalt • • Stone • • Gravel • • Slag

Galion Spreaders can spread material in an even layer of any desired depth. Screw adjustment for depth of strike-off plate, easily operated even while spreading.

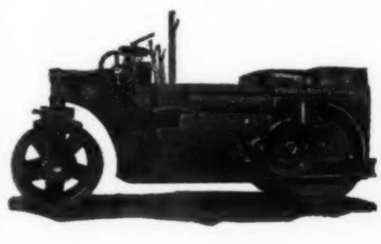
Notice how evenly Asphalt is being spread in the photograph above. Ready for the roller immediately without unnecessary hand shoveling and raking.

The spreader is placed behind a truck and chains attached. As the truck moves forward, dumping its load slowly, the spreader lays the material smoothly and evenly.

Two 8-foot spreaders will spread an 18-foot course or two 9-foot spreaders will spread a 20-foot course. Adjustable cut-off plates are furnished for less than 18-foot roads.

Double wheels and long shoes under spreader assure an even course and prevent it cutting into sub-grade.

Galion Spreaders are strong and sturdy, practical and efficient. Write for particulars.



Galion makes a roller for every job. Tandem type shown above.

The Galion Iron Works & Mfg. Co.
GALION • • • • OHIO

Galion Distributors

W. A. Adams Tractor & Equip. Co., Raleigh, N. C.
R. S. Armstrong & Bro. Co., Atlanta, Ga.
O. B. Avery Co., St. Louis, Mo.
Badger Tractor & Equip. Co., Milwaukee, Wis.
W. D. Banker Road Machy. Co., Memphis, Tenn.
Banks-Miller Supply Co., Huntington, W. Va.
Borchert-Ingersoll, Inc., St. Paul, Minn.
Brown-Fraser & Co., Ltd., Vancouver, B. C.
Dukehart Machy. Co., Des Moines, Iowa
Eastern Tractor Co., Cambridge, Mass.
Feenaughty Machy. Co., Portland, Ore.
Frankfort Equip. Co., Frankfort, Ky.
Good Roads Machy. Co., Inc., New York, N. Y.
Hall Perry Machy. Co., Butte, Mont.
Herd Equip. Co., Oklahoma City, Okla.
Interstate Machinery & Supply Co., Omaha, Nebr.
Jeffrey Mfg. Co., Ltd., Montreal, Que.
Jenison Machy. Co., San Francisco, Cal.
C. H. Jones Co., Salt Lake City, Utah
Lewis-Patten Co., San Antonio, Texas
Lewis Tractor & Machinery Co., Fargo, N. D.
Miller & Requarth, Springfield, Ill.
Morrow Auto Co., Albuquerque, New Mexico
H. W. Moore Equip. Co., Denver, Colo.
Morrisey Easton Tractor Co., Vicksburg, Miss.
Murphy & Murphy, Little Rock, Ark.
Northfield Iron Company, Northfield, Minn.
C. T. Patterson Co. Inc., New Orleans, La.
G. C. Phillips Tractor Co. Inc., Birmingham, Ala.
Power Equip. & Service Co., New Haven, Conn.
F. Ronstadt Co., Tuscon, Ariz.
Salina Tractor & Thresher Co., Salina, Kan.
Bert Smith, Enid, Okla.
Smith-Booth-Usher Co., Los Angeles, Cal.
Standard Road Equip. Co., Rockford, Ill.
W. H. Stoutenburg, Penn Yan, N. Y.
Tennessee Tractor Co., Nashville, Tenn.
F. E. Vaughn, LaCrosse, Kan.
Virginia Road Machy. Co., Richmond, Va.
Welch Good Roads Supply Co., Welch, W. Va.

ROADS AND STREETS

H. P. Gillette Editor

Vol. LXX JULY, 1930 No. 7

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